Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

OCTOBER, 1955 TECHNOLOGY DEPT.

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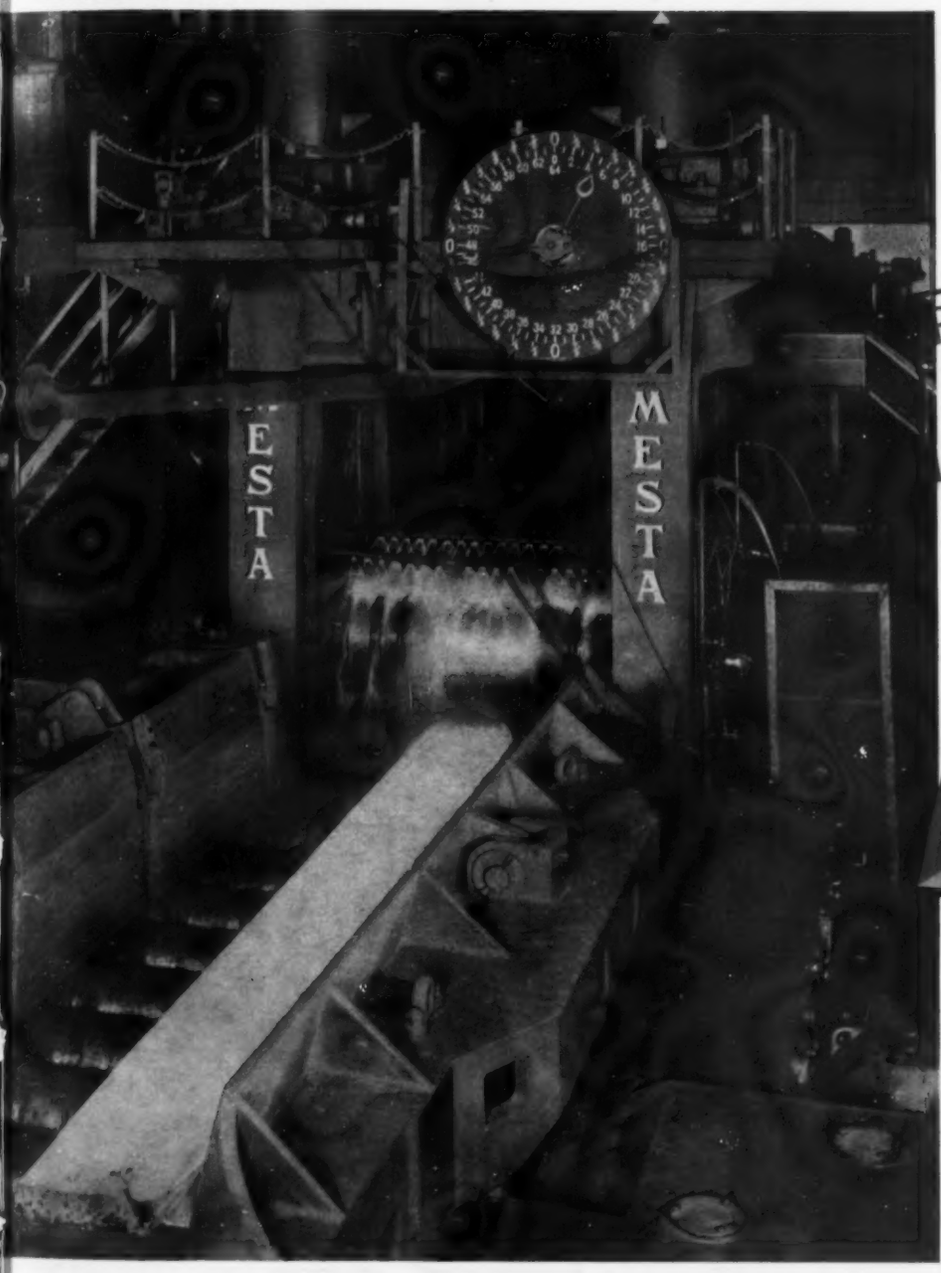

Mesta 46" Reversing Slabbing-Blooming Mill

SLABBING - BLOOMING MILLS

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DETROIT

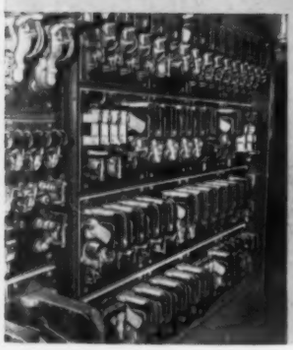
Designed and Built by MESTA

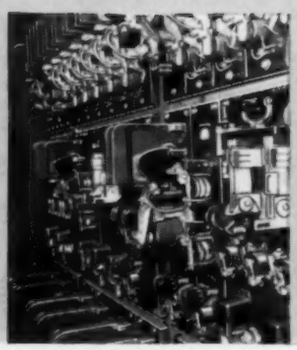
for SOUTH AFRICAN IRON AND STEEL INDUSTRIAL CORPORATION, LTD.

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA





TONNAGE

inside a cordon of safety.

The Cutler-Hammer story at the Fairless Docks

TONNAGE—moving inside a cordon of safety—is the picture here at Fairless ore docks. The two unloaders and one ore bridge can move a total of 3400 net tons of ore per hour, free digging. The trolleys travel at speeds up to 1000 feet per minute. Here, Cutler-Hammer applied its unique and exclusive Wilson-Ritchie emergency dynamic braking control. Also furnished on the trolleys is Cutler-Hammer's "Speed-Distance" end zone protection. Each hoisting line is further protected against over-hoisting of the bucket and excessive cable pay-off. Interlocking between the control and an anemometer panel prevents operation of the rigs in unfavorable wind conditions. Both power and control automatic over-skew protection is provided for the travel motion of the ore bridge.

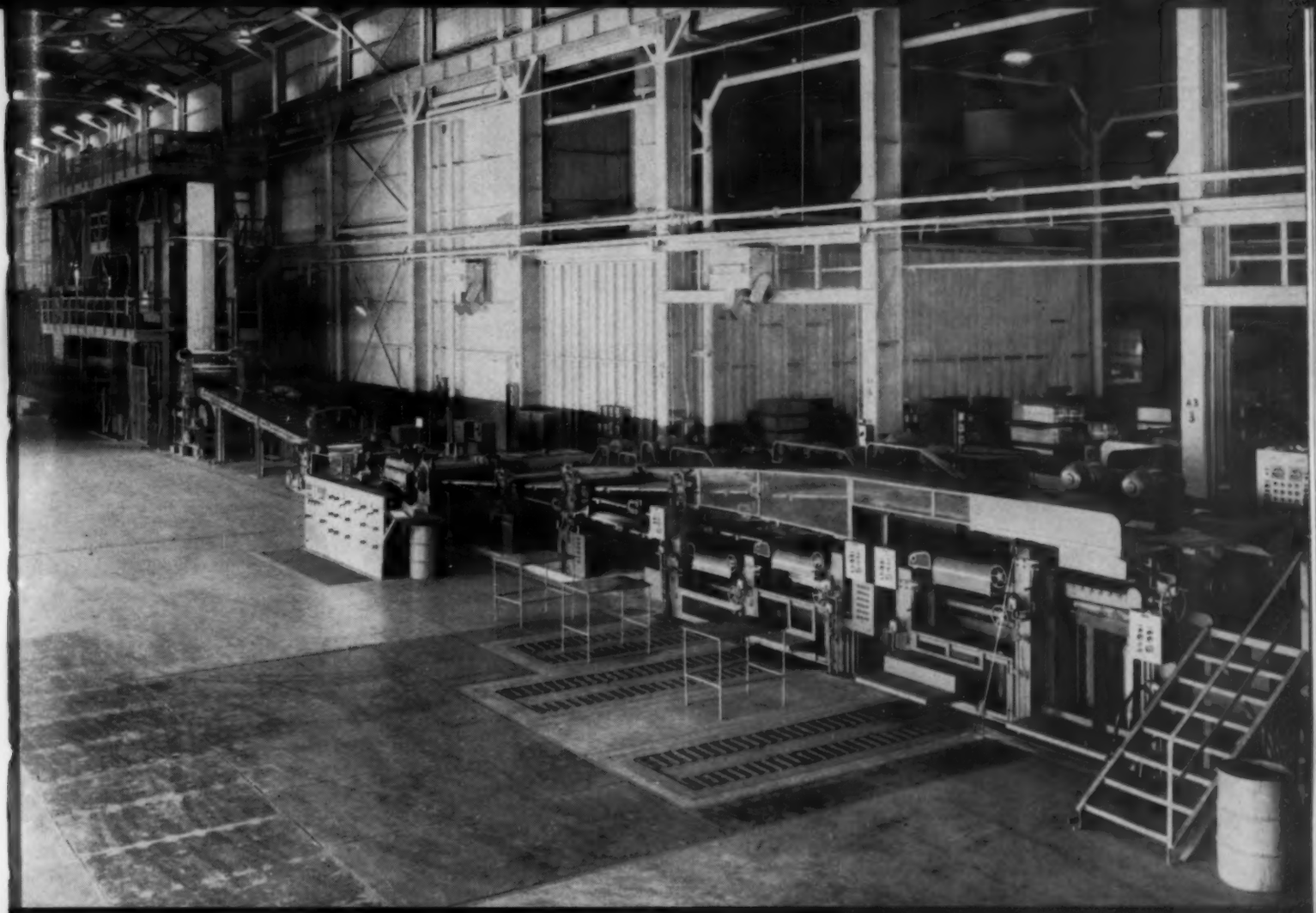
"FABULOUS" IS THE WORD

to describe the new U. S. Steel Fairless Works. The entire mill represents engineering thought carried to the perimeter of development and discovery. And anybody who follows *that* thought through to its logical conclusion will know why the name that appears on the motor control for the ore unloaders and ore bridge is Cutler-Hammer. It is *NOT* strange coincidence that puts Cutler-Hammer Control on so many outstanding achievements in so many divisions of the steel and metal industry. It is the fact that Cutler-Hammer has pioneered and blazed new trails since 1892. That C-H has amassed tremendous control engineering knowledge. That C-H engineering thought is the *break-away* and *break-through* type that goes straight-line to sure and sound solutions that mean dependability, productiveness, profit. All this knowledge and experience is available to you . . . at any time, whether for a proposed installation or an existing troublesome application in your mill. Look to Cutler-Hammer for experience as broad as it is long. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

CUTLER-HAMMER
MOTOR CONTROL
C-H

LOOK TO CUTLER-HAMMER MILL EXPERIENCE...AS BROAD AS IT IS LONG

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., Pittsburgh, Pa. Second class mail privileges authorized at Pittsburgh, Pennsylvania, January 25, 1924.



NEW ELECTROLYTIC TINNING LINE

"Ferrostan" Electrotinning Line Acclaimed

built by ***AETNA-STANDARD***

for TENNESSEE COAL & IRON DIVISION, U. S. STEEL CORPORATION

More rugged design, improved Tracking, Shearing and Classifying, Pickling and Cleaning. Line is designed to be the largest capacity, highest speed line of its type to date.

THE AETNA-STANDARD ENGINEERING COMPANY • PITTSBURGH, PA.

Aetna-Standard

PLANTS IN WARREN, OHIO • ELLWOOD CITY, PENNSYLVANIA

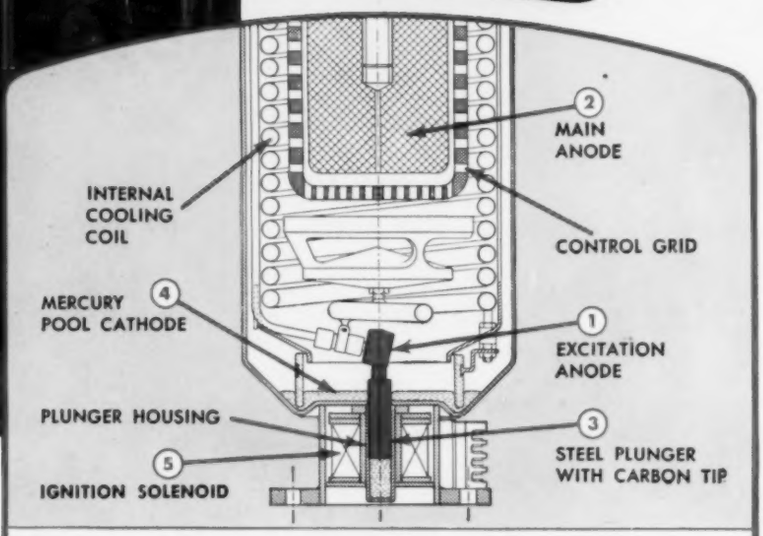
GOOD EQUIPMENT BRINGS DOWN PRODUCTION COSTS

Here's the Rectifier That Needs

No Delicate Adjustments

This 1000-kw, 6-tube excitron rectifier is typical of units used for heavy-duty service in many industrial plants.

ALLIS-CHALMERS
Mercury Arc Rectifiers



Unique Plunger Starts Continuous Excitation

The excitron tube has an excitation anode ① in addition to the main anode ② . With the excitation circuit de-energized, the steel plunger ③ floating in the mercury pool cathode ④ makes positive contact with the excitation anode (as shown).

When the excitation circuit is energized, the ignition solenoid ⑤ pulls the steel plunger ③ away from the excitation anode ① and under the mercury pool cathode ④ , thus drawing a dc arc and forming the cathode spot, which makes conduction of load current by the tube possible.

If power is interrupted the plunger will float up, contact the excitation anode and automatically re-establish the excitation arc when power is restored.

LITTLE MAINTENANCE IS NEEDED with Allis-Chalmers excitron-type rectifiers. Excitation of the excitron rectifier is continuous, while other types of rectifiers require re-ignition 60 times a second.

Since it is more difficult to start a rectifier arc than to maintain it, the excitron rectifier is much less likely to lose excitation during operation. Momentary dips in supply voltage which are encountered in many supply systems have no effect on the continuous excitation arc.

Years of operation in hundreds of installations have proved the reliability and ease of operation of Allis-Chalmers mercury arc rectifiers. You can get complete information from your nearby A-C office. Or write Allis-Chalmers, Milwaukee 1, Wis.

A-4581

ALLIS-CHALMERS

mated for a better life!

matched pairs of

LEWIS ROLLS

mean minimum grinding, greater productivity, lower cost of tonnage rolled

Remember, the tonnage you get from a pair of rolls is no better than what the roll of minimum diameter will deliver.

LEWIS realizes this and is doing something about it. Pairs of rolls from each heat are matched for diameter. A label is pasted on the end of the wabbler of each roll of each matched pair as it leaves the foundry, giving the roll number of its mate. Thus, the matched pairs can be quickly identified.

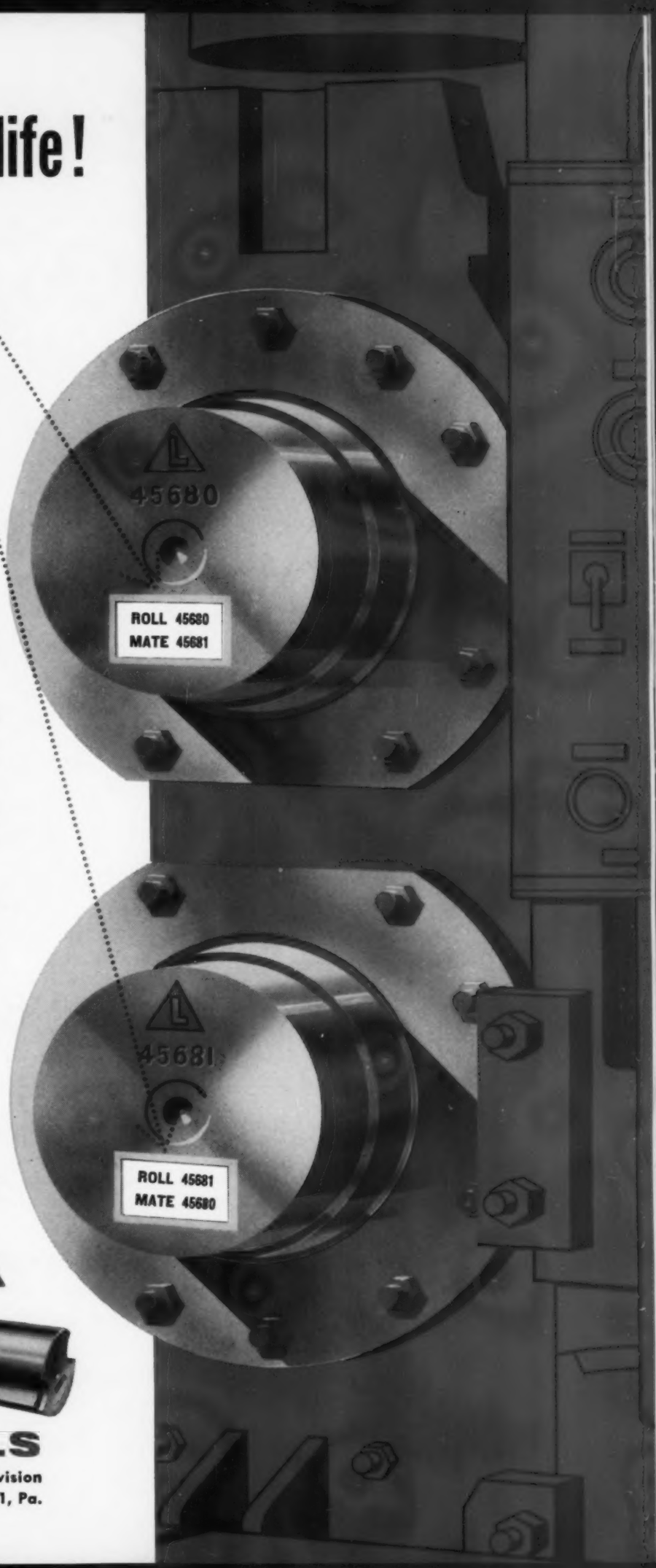
This LEWIS service helps the mill operator use rolls of the same diameter in a particular mill, with minimum grinding, and greater tonnage of quality products.

That's just another reason why you should always specify and use *quality* LEWIS ROLLS. They cost you less in the long run.

OVER 95 YEARS OF ROLL MAKING—

Superior "X" Rolls • Ajax Duplex Rolls • Lewis "X" and "XA" Rolls • Special Process Rolls • Climax and Ajax Rolls • Plain Chilled Rolls • Special Tube Mill Rolls • Atlas, Atlas "B" and Atlas "X" Rolls • Molybdenum Chilled Iron Rolls

Matched Rolls Mean Greater Tonnage



BLAW-KNOX

LEWIS ROLLS

BLAW-KNOX COMPANY • Rolls Division
Lewis Rolls Department • Pittsburgh 1, Pa.

Unique test furnace assures you of better end wall service

with Kaiser Periclase-Chrome Brick

THE refractory test furnace shown at the right was designed by Kaiser Chemicals to aid in the development of superior basic refractories for the steel industry.

One of the most important of its functions is to regularly test the effect of iron oxide and steel furnace slag on various bricks—including Kaiser Periclase-Chrome Brick.

As a result of such careful quality development and control, Kaiser Periclase-Chrome Brick are superior in your furnace—assuring less spalling, less swelling, greater resistance to abrasion and alteration by oxide and slag.

Leading steel producers have found that Kaiser Periclase-Chrome Brick can greatly increase end wall life or greatly reduce wall thickness, when this is preferred.

Let your Kaiser Chemicals sales engineer show you how you can get longer life from your end walls or reduced wall thicknesses with Kaiser Periclase-Chrome Brick. Call or write any of the sales offices listed below for immediate attention to your particular problem.

Call or write Kaiser Chemicals Division, *Kaiser Aluminum & Chemical Sales, Inc. Regional Sales Offices: 1924 Broadway,* OAKLAND *12, Calif. . . . 3 Gateway Center,* PITTSBURGH, *Pa. . . . 518 Calumet Building, 5231 Hohman Ave., Hammond, Indiana* (CHICAGO).

For the ultimate in steel furnace refractories

SOME OF THE REASONS YOU GET BETTER SERVICE WITH KAISER PERICLASE-CHROME BRICK:

1. Chromite content is the minimum amount (only 9.1% Cr_2O_3) necessary to provide thermal shock resistance. Lowering of chromite reduces swelling, thus minimizes end wall buckling.
2. A ceramic bond is formed *before* the chemical bond is destroyed.
3. No liquid phase in forming its ceramic bond. Volume stability.
4. Highest MgO content in end wall brick provides greater resistance to carryover erosion and iron oxide attack.
5. Lowest porosity minimizes alteration by resisting penetration of gases and impurities.

think of Kaiser Chemicals

Pioneers in Modern Basic Refractories

REFRACTORY BRICK • RAMMING MATERIALS • CASTABLES & MORTARS • MAGNESITE • PERICLASE • DEADBURNED DOLOMITE

Kaiser PERICLASE Brick for the Steel Industry:

- Kaiser Periclase Brick (D-S)
- Kaiser Periclase Chrome Brick
- Kaiser Chrome Periclase Brick

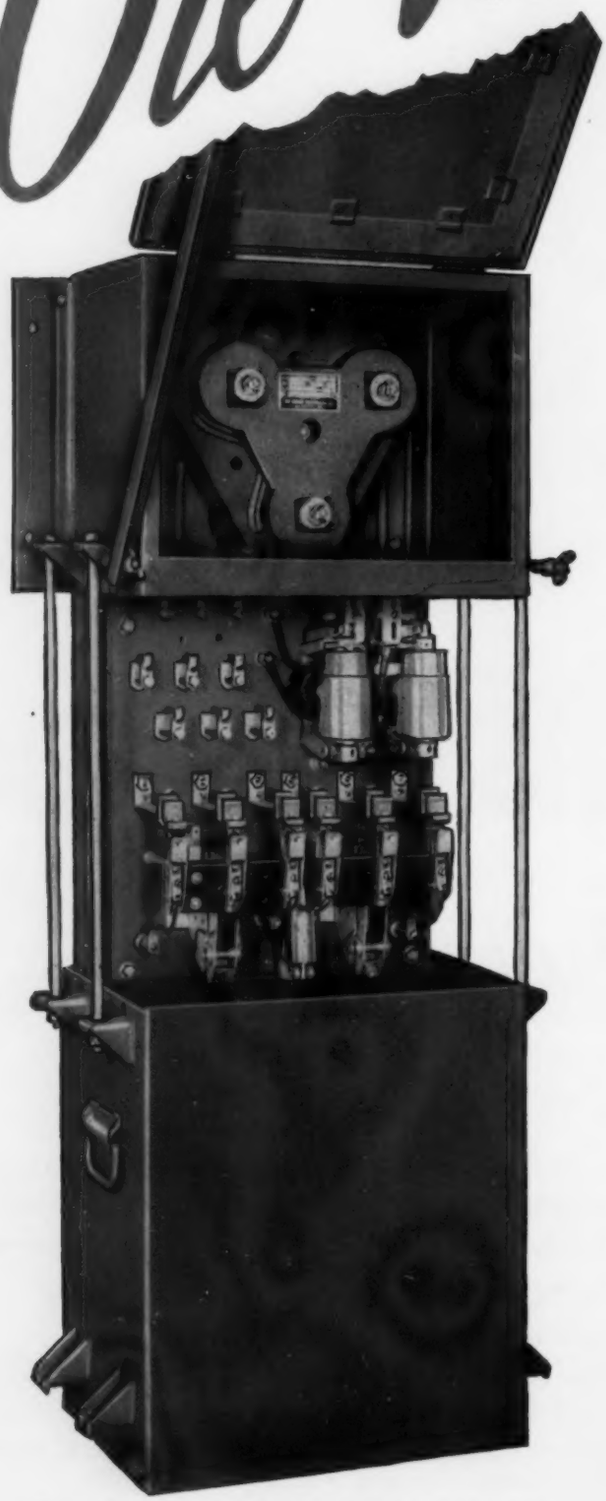
Now available! **A companion mortar for Kaiser D-S brick. High purity periclase composition *and* maximum workability.**

Installation advice on request

Oil Immersed

REDUCED VOLTAGE STARTER OF THE IMPEDANCE TYPE

900 Series



Type 900-B, Frame 100, Reduced Voltage Starter of the Impedance Type

Push button operated — fully automatic — Rowan 900 Series, oil immersed, reduced voltage starters of the impedance type give your induction motors a smooth start with a minimum of line disturbance.

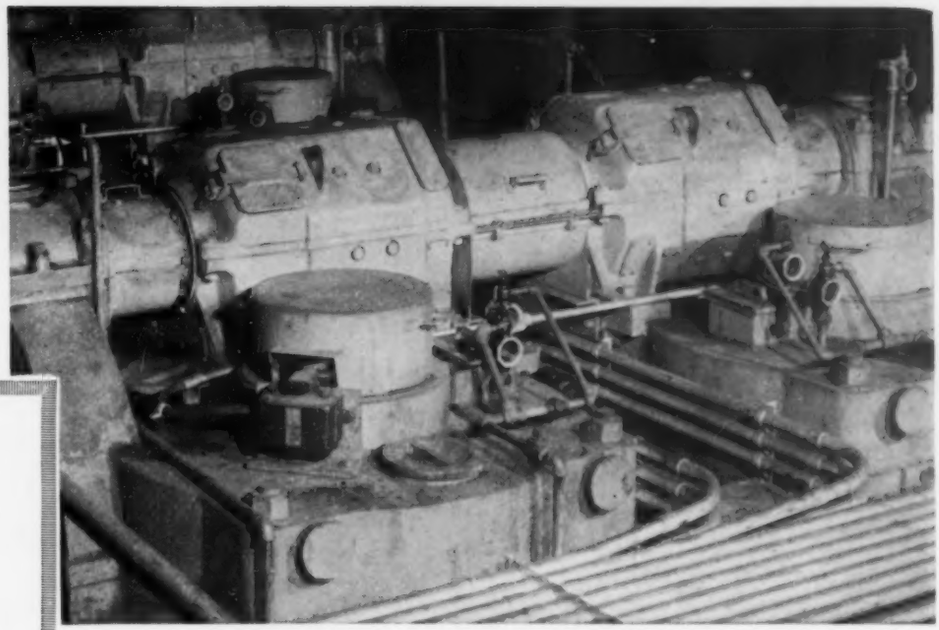
The 900 Series starters include such features as: a closed transition, utilizing for acceleration a combination of voltage and time; an acceleration period dependent upon driven equipment and load, which eliminates the human element; continuous wound impedance coil assures freedom from tap failures — impedance is adjustable to each application; magnetic overload relays provide a combination of inverse time element and instantaneous operation.

Combination starters include: Rowan time-tested **AIR-SEAL** fuses providing dependable short circuit protection; sealed-off centralized wiring compartment; provision for straight through conduit connections; tank and disconnect mechanism mechanically interlocked to prevent the lowering of the tank before disconnecting the line disconnect switch.

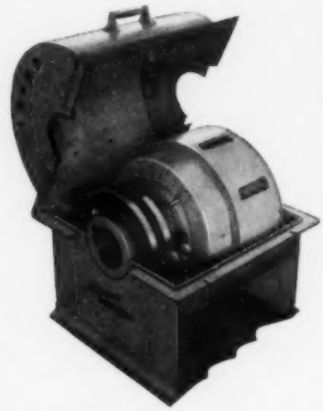
Enclosures are of weather-resistant design to meet NEMA Type XI requirements and are available also for NEMA Type VIII, Class I Group D locations.

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.



Five Stearns clutches synchronize screw-downs on a large rolling mill. Covers shield clutch from dust, moisture and external damage.



Style E multiple-disc Stearns magnetic clutch used for screw-down duty. Sizes available for all screw-down auxiliary motors.

Low Inertia Stearns Magnetic Clutches Keep Screw-Downs Synchronized on Mile-a-Minute Rolling Mills

QUICK-ACTING, high-torque Stearns magnetic clutches engage and disengage screw-down drives with the lowest possible inertia — a prime necessity on today's rolling mills running at speeds often greater than 6,000 fpm. Because of their high efficiency, more Stearns magnetic clutches are used on steel mill screw-downs than all other makes combined. Here are some of the features that have put Stearns out front, and keep it there:

Precision automatic control — Clutches can be operated through push buttons, electric-eye systems, remote switches or manual controls.

Lightweight, compact — Stearns patented multiple friction-disc clutches provide greater torque than bulky, far heavier single-disc types — offer extremely low inertia value to driven end. This is especially important when little or no drifting is desired after clutch is disengaged.

Few wearing parts — No toggles, pins, yokes, shifters to wear and get out of order. Lining wear increases torque, making frequent adjustment unnecessary.

Simple adjustment — No set screws, cams, wedges, spacers or lock nuts. Simply depress adjustment lock-pin, rotate armature to next notch.

Easy access — Can be removed vertically with motor from mill. Housing covering entire unit is split either horizontally or vertically for easy inspection. Magnetic hub is detachable when used on screw-downs.

For improved quality control it will pay you to replace old-style clutches with new Stearns multiple-disc clutches on existing installations . . . specify Stearns for new mills. Write for complete details.

1121

MAGNETIC EQUIPMENT FOR ALL INDUSTRY

STEARNS MAGNETS

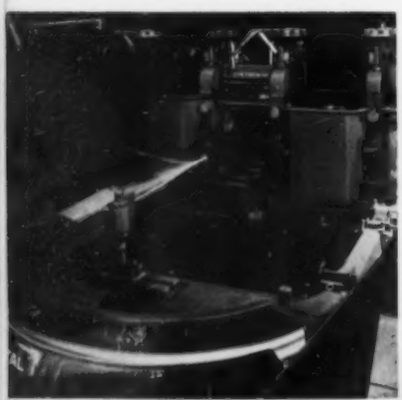
STEARNS MAGNETIC, INC., 681 S. 28th St., Milwaukee 46, Wisconsin

ROLL BARS AT LESS COST on a Continental mill like this

Complete mechanical handling speeds up production

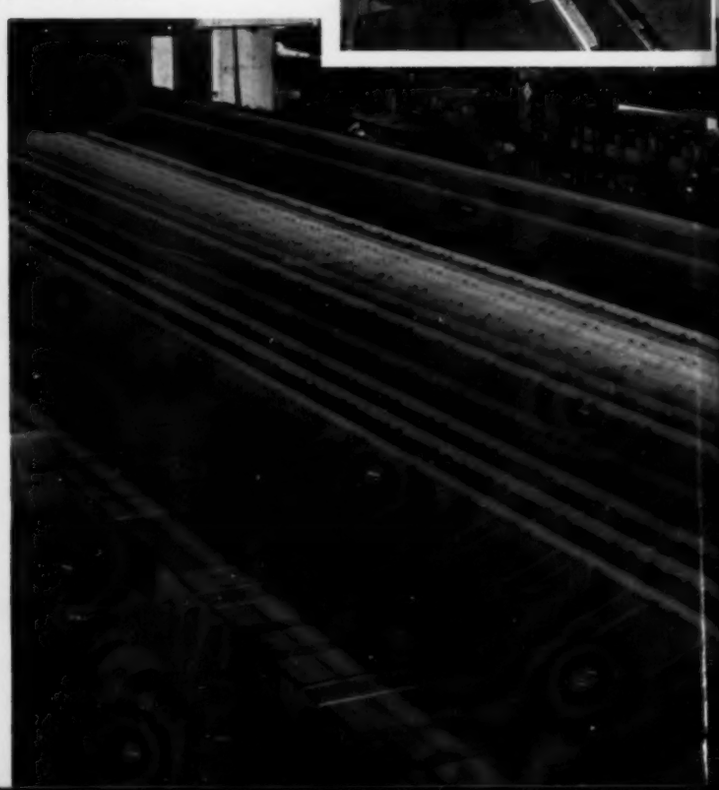
You don't see any tongsmen on this CONTINENTAL merchant bar mill. They are not needed. CONTINENTAL skew tables, repeaters, snip shears, drag-over transfers, test bar and parting shears furnish bed lengths to a fully mechanized cooling bed arranged for automatic control, and at low cost. These are some of the features incorporated on a new CONTINENTAL merchant mill, or they can be added to your present mill.

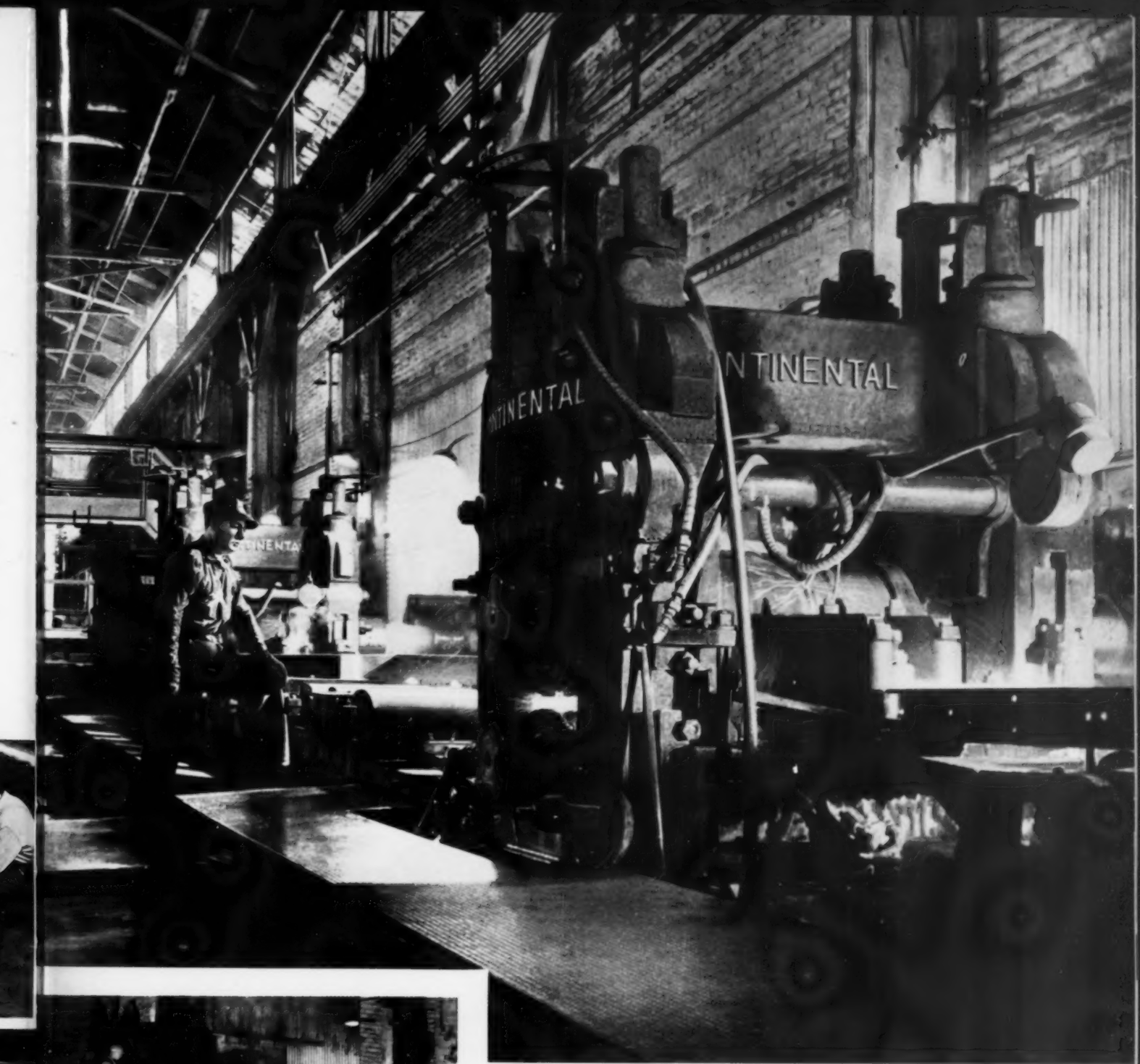
CONTINENTAL makes *all* types of rolling mills for ferrous and non-ferrous metals . . . assumes complete responsibility from preliminary design to final satisfactory operation. And every CONTINENTAL installation is custom designed to meet your specific needs.



NO TONGSMEN NEEDED. Heavy section product is moved from one line of travel to another by means of CONTINENTAL drag-over transfer tables, skew roller tables, and chutes. Automatic bar turners turn the bars up for entry into various stands. Lighter bars are repeated. The end of each bar is automatically prepared for repeating by a CONTINENTAL snip shear.

600-FT. BARS CUT COSTS. Instead of making a great many 200-ft. bars, which would increase handling, scrap, and cost, bars are made in lengths of 600-ft. Each bar is automatically cut off by a CONTINENTAL parting shear in the run-out table. This cooling bed can operate as a notch bar bed or as a flat bed. It can handle irregular sections as well as plain sections.





CONTINUOUS ROUGHING. Two-high stands are used throughout this CONTINENTAL installation. They are much more rigid than three-high mills, give better tolerances in the finished product. A complete range of bar products can be made on this mill, with complete mechanical handling. CONTINENTAL designed the entire installation, including all auxiliaries.

CONTINENTAL

Engineering and Sales Offices
220 Grant St., Pittsburgh 19, Pa.

General Offices
144 Railroad St., East Chicago, Ind.

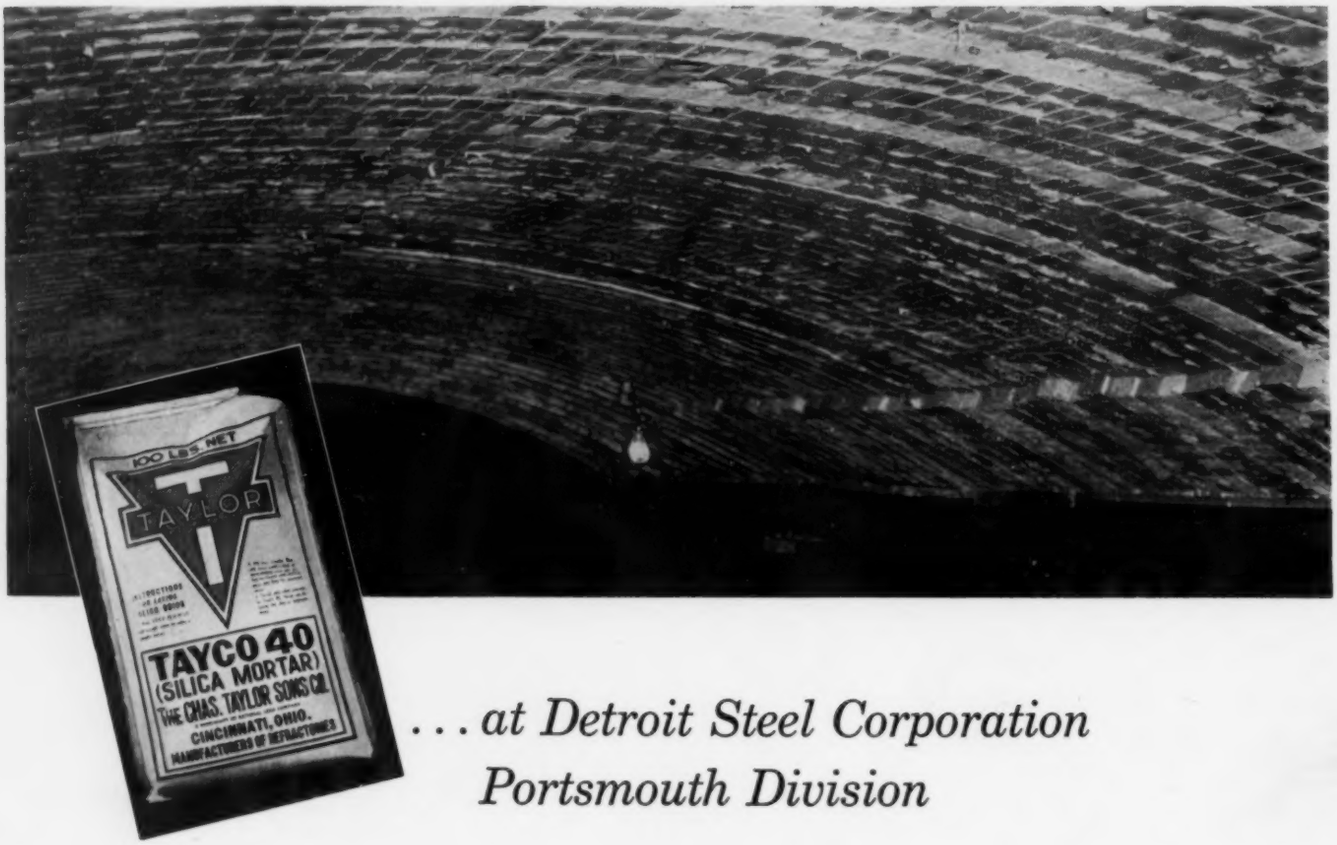
***Plants at* East Chicago, Indiana, Wheeling, W. Va., Pittsburgh, Pa.**

***Copes-Vulcan Division*, Erie, Pa.**

CONTINENTAL
Foundry & Machine
Company

Tayco 40 BONDS THE ROOFS...

Photograph courtesy of Detroit Steel Corporation



. . . at Detroit Steel Corporation Portsmouth Division

The Portsmouth Division, Detroit Steel Corporation—as well as other leading steel mills in the United States—is using Tayco-40 High Temperature Silica Cement to improve the life of silica open hearth furnace roofs.

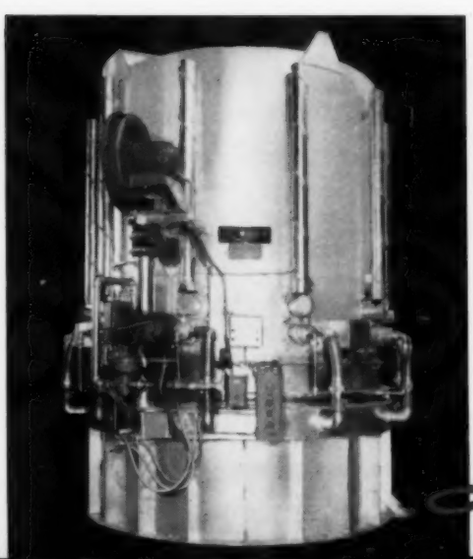
Tayco-40 is nearly as refractory as the best grades of silica or super-duty silica brick. Because of its superior water-retention properties, Tayco-40 is smooth working—remains plastic longer—making it easy to lay brick with thin, tight joints. These properties are obtained without the addition of plastic fire clays found in most silica cements.

If your open hearth shop has not yet tried Tayco-40, see the Taylor field engineer in your district or write direct for a sample and copy of Bulletin No. 507.

Exclusive Agents in Canada:
REFRACTORIES ENGINEERING AND SUPPLIES, LTD.
Hamilton and Montreal

The CHAS. TAYLOR SONS Co.
A SUBSIDIARY OF NATIONAL LEAD COMPANY
REG. U. S. PAT. OFF.
REFRACTORIES SINCE 1864 • CINCINNATI • OHIO • U. S. A.

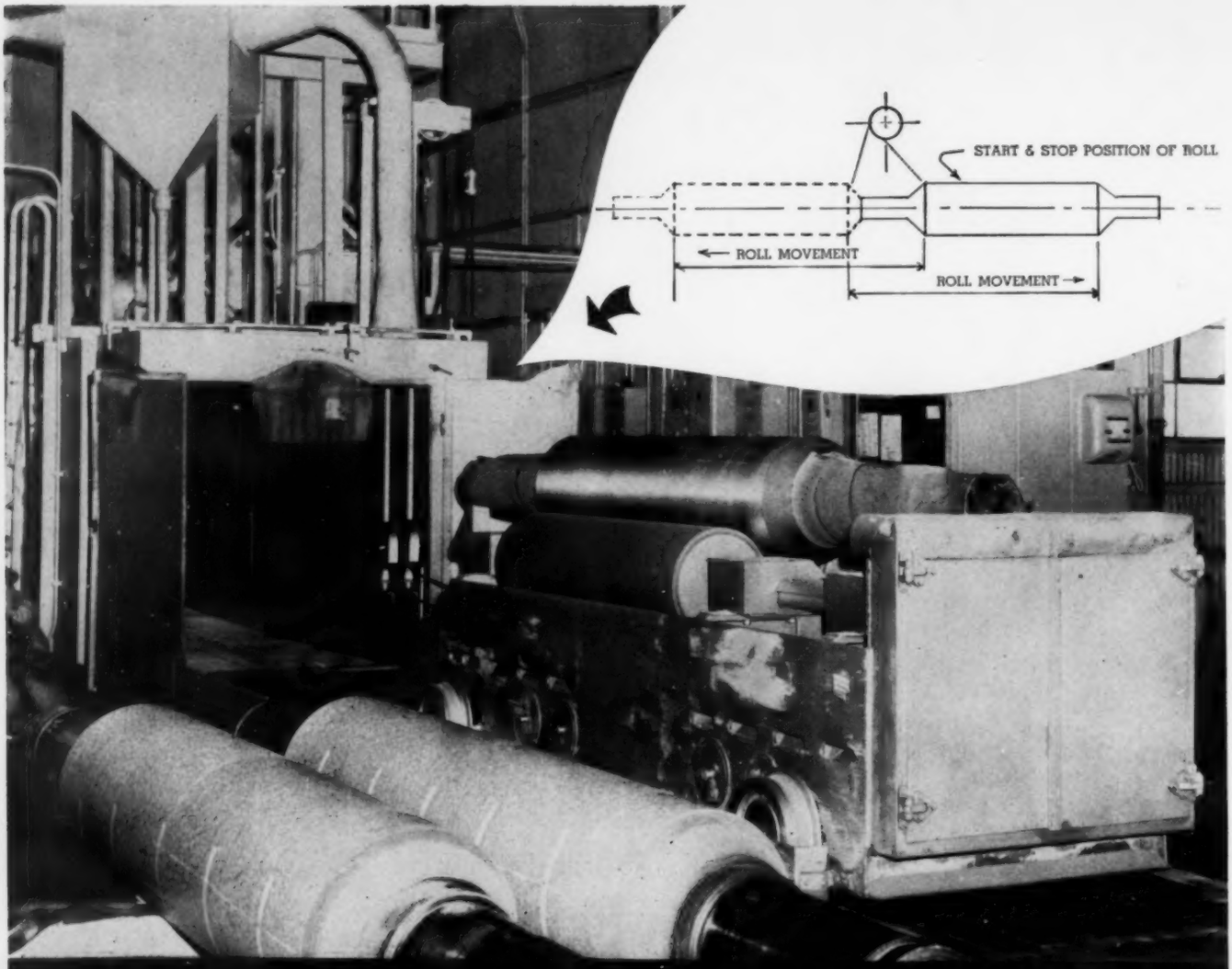
We tamed a torrid tornado to bring you better Annealing



Torrid heats swirling at speeds of more than a mile a minute—that's the **tornado type** heating that makes the new Lee Wilson High Convection Annealing Furnaces the fastest, most efficient units of their kind available today.
They get to heat fast, completely saturating the entire charge with an evenness that assures perfect uniformity of anneal.
The result of years of experience by the originators and leading producers of radiant tube, single-stack annealing systems, these new furnaces represent the most advanced strip coil annealing equipment marketed today.
Get all the facts and you'll get Lee Wilson—brochures and data sheets available upon request.

Lee Wilson ENGINEERING COMPANY-INC.

20005 WEST LAKE ROAD • CLEVELAND, OHIO



FAST, UNIFORM MILL ROLL ETCHING IS AUTOMATIC WITH A *WHEELABRATOR*®

Compare your mill roll etching time with this actual performance of an airless Wheelabrator: Rolls up to 9 inches in diameter in 54 seconds; rolls up to 27 inches etched in 3 minutes.

And Wheelabrator gives a uniform etch because the roll rotates and moves laterally at uniform speed as it passes under the entire blast pattern in both directions as indicated in the sketch above. You never get any "barber pole" effect with a Wheelabrator.

Completely automatic, the machine requires no special skill or judgment by the operator, and the finish obtained is extraordinarily deep and uniform, even for the hardest rolls. This depth and uniformity extend roll life as much as 35% and products processed on the rolls receive an etch that is deep and uniform.

Add up all these advantages and you see why the Wheelabrator method is the most efficient mill roll etching process yet devised.

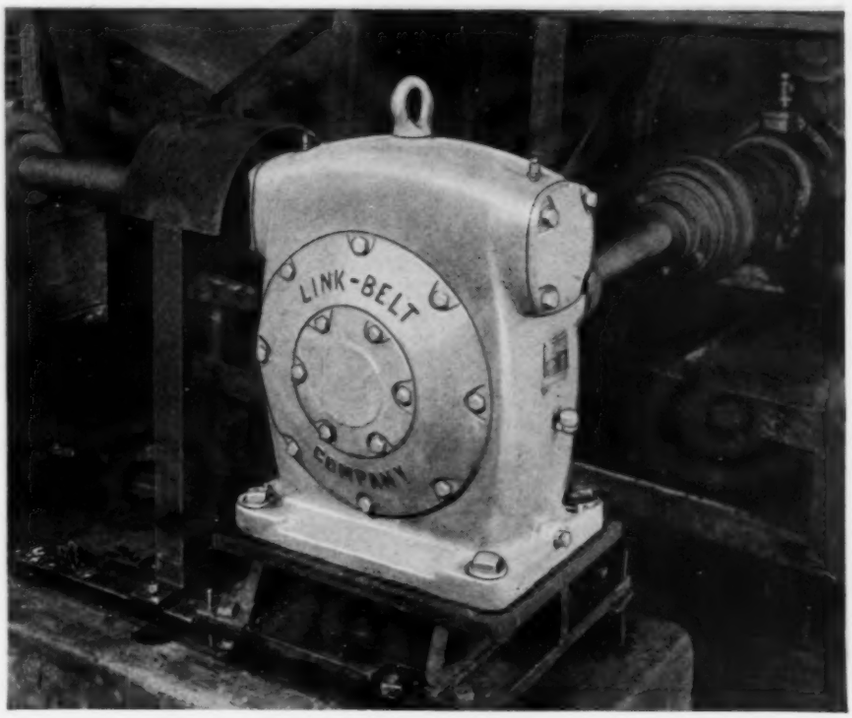
A Wheelabrator cabinet can be tailored to fit your specific needs. Send today for more complete information.

WHEELABRATOR
CORPORATION
(Formerly American Wheelabrator & Equipment Corp.)

396 S. Byrkit Street Mishawaka, Indiana

First in Mechanical Descaling

Here's industry's most comprehensive line of WORM GEAR DRIVES



Reel at the wind-up end of paper machine is driven through a dependable Link-Belt Worm Gear Drive.

Type WB — Single reduction, worm below gear, horizontal output shaft.

Type WV — Single reduction, vertical output shaft (up or down).

Type HWB — Helical gear first reduction, worm gear final reduction. Worm below gear, horizontal output shaft.

Type HWV — Helical gear first reduction, worm gear final reduction. Vertical output shaft (up or down).

Type DWB — Double worm reduction gear, horizontal output shaft.

Type DWV — Double worm reduction gear, vertical output shaft (up or down).

Type WVS — Single reduction, worm on top of gear, horizontal shaft with screw conveyor flange.

Type WVT — Single or double reduction overhead conveyor drive.

FOR efficient, high-ratio, right-angle speed reductions, choose from the complete Link-Belt line of worm gear drives. A wide selection of single-worm, double-worm and helical-worm gear reductions assures you of the best drive for large and fractional horsepower requirements.

All three types are available with horizontal and vertical housings to permit convenient, compact connections to prime movers and driven machinery. And a choice of two shaft diameters facilitates direct connection or the accommodation of heavy overhung loads.

Single Worm Gear Drives are offered in ratios from $3\frac{1}{10}$:1 to 100:1 with output capacities up to 97.9 hp.

Helical Worm Gear Drives are available in ratios from 26:1 to 540:1 — output capacities up to 56.7 hp.

Double Worm Gear Drives have ratios from 26:1 to 8000:1—output capacities up to 26 hp and 124,800 inch pounds torque.

Get all the facts on Link-Belt Worm Gear Drives. Contact your Link-Belt office or authorized stock-carrying distributor. Or write today for Book 2324-A.

LINK-BELT

ENCLOSED DRIVES

13.873

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

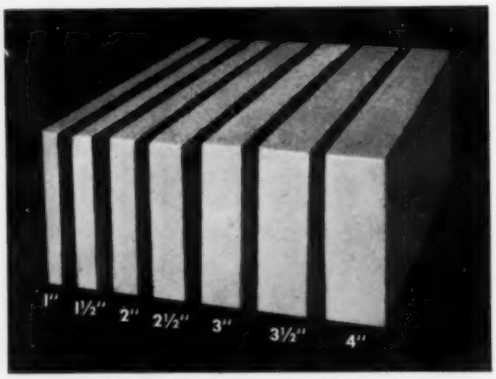
Specify J-M Superex, industry's favorite block insulation

Made from diatomaceous silica and asbestos for all temperatures to 1900F

YOU'LL ENJOY *greater insulation savings* with Superex®. Its unique combination of low conductivity and outstanding resistance to high temperatures provides greater operating efficiency and longer maintenance-free service. That's why Superex is the leading block insulation for furnace work.

Light and easy to work. Superex withstands temperatures to 1900F indefinitely with negligible loss of efficiency and is so strong that it compresses only ⅛ inch under 6 tons' pressure per square foot. Its light weight, excellent working properties and availability in large blocks mean quick, easy, low-cost installation.

For high temperature equipment. Since its introduction in 1927, Superex has received enthusiastic acceptance. Today it economically insulates 90% of the country's hot blast stoves. Other high temperature equipment where Superex has proved its superior performance include most types of industrial and metallurgical furnaces and ovens, stationary and marine boilers, regenerators, kilns, roasters, high-temperature mains, flues and stacks.



Saves waste—Superex comes in 7 standard thicknesses from 1" to 4". Other sizes available on order.

For further information on Superex, write to Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ont.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville *first-in* INSULATION

MATERIALS · ENGINEERING · APPLICATION

79 YEARS of Lubrication Service to Industry

Brooks lubrication engineering—constant research in the laboratory and "on the job" has been devoted exclusively to the development of industrial lubricants. The wealth of experience and knowledge gained through solving the "tough" lubrication jobs of industry during the past seventy-nine years has resulted in a dependable extreme pressure lead base compound known throughout industry as "Leadolene Klingfast." Hundreds of case studies prove that it lowers lubrication costs and increases service life of equipment. We suggest you try it for trouble-free, economical lubrication of the following:

OPEN GEARS • SCREW DOWNS
MILL TABLES • WIRE ROPE • MILL PINIONS
HIGH TEMPERATURE LUBRICATION
HYDRAULIC SYSTEMS • CIRCULATING OIL
SYSTEMS • FLEXIBLE COUPLINGS
WORM DRIVES • ROLLER BEARINGS
ENCLOSED GEARS AND BEARINGS

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Write for your copy of "The Brooks Oil Story!"

The Brooks Oil Company

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Cuban Office—Santiago de Cuba

Characteristics of LEADOLENE KLINGFAST

pH-ilm Strength . . . 50,000 psi minimum.

Adhesiveness . . . Affinity for metal develops maximum adhesion providing permanent coating on gears.

Water Repellence . . . Effectiveness is not reduced by water.

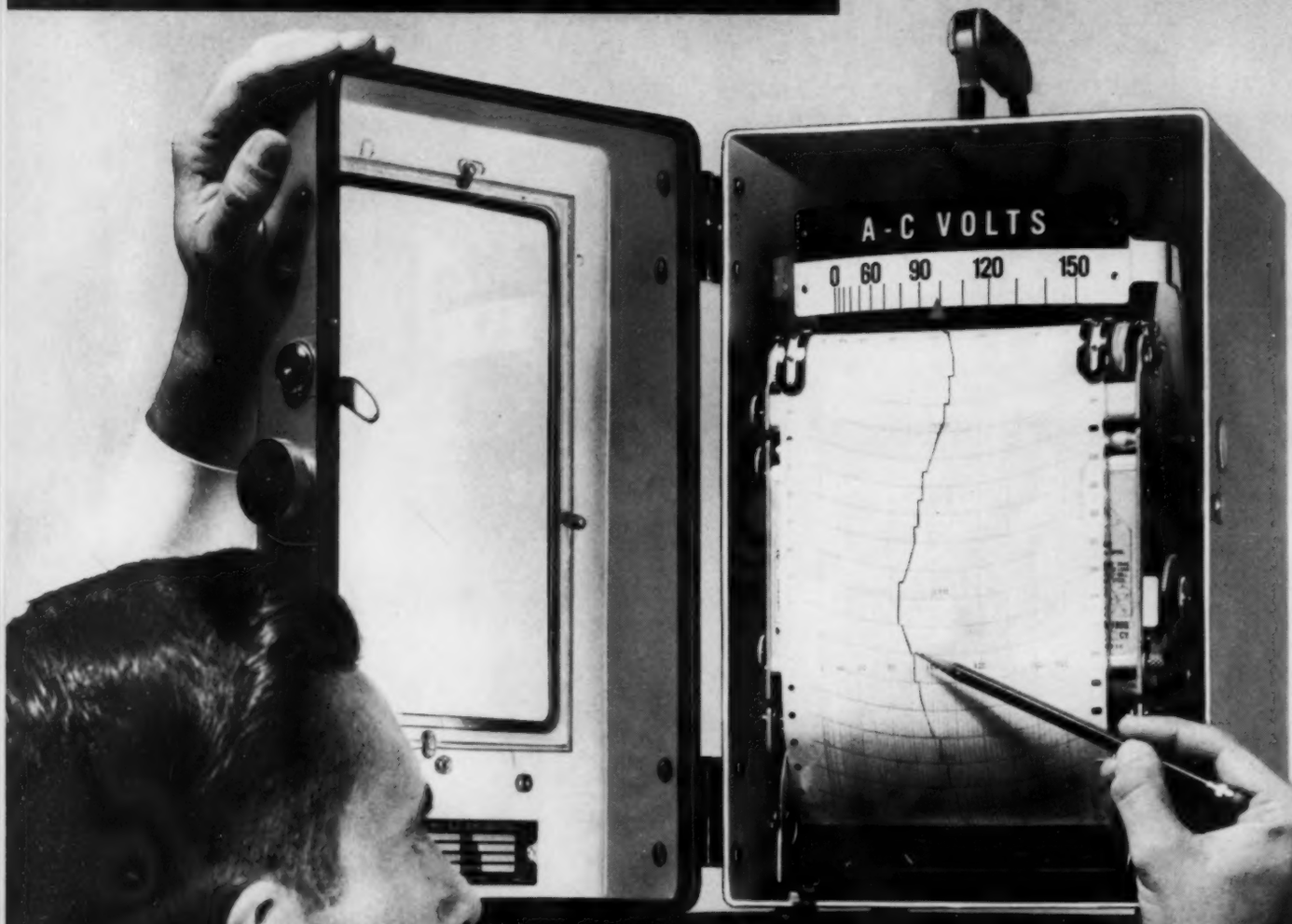
Corrosion Prevention . . . Never acidic and will not etch or corrode.

Compounded Stability . . . Will not bleed or change physical condition within a greater temperature range.

Low Temperature Factors . . . Does not harden, crack or decrease in adhesion.

Abrasive Resistance . . . Repellent to adhesion of scale, metallics and other contamination.

Instruments for Productive Maintenance



VERSATILE NEW G-E RECORDER

CHART SPEEDS from ¼ inch per hour to 120 inches per minute are standard on the double-speed, motor-driven chart carriage. Speeds are set by using simple instructions on the front of the carriage.

G-E RECORD ROLLS provide high color contrast between chart lines and ink. Switchboard recorders have fluorescent lamps for maximum glare-free chart illumination.

NEW General Electric Recorder Assures Sharp, Clear Records

Unique G-E Writing System Has Throw-away Inkwell; One of Six Outstanding New Cost-saving Advantages

UNIQUE WRITING SYSTEM in the new G-E general purpose recorder makes records more accurate and readable with sharp, clear pen traces. Switchboard and portable models of the new instrument can measure and record current, voltage, power, frequency or speed. Drives are synchronous motor or spring clock.

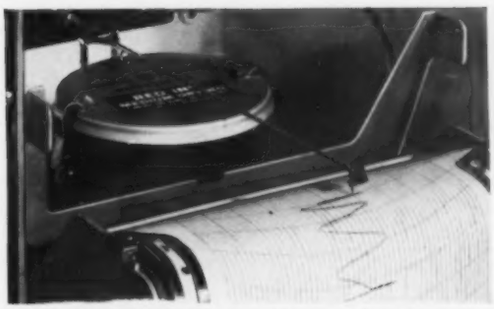
NEW THROW-AWAY INKWELL makes service quick and easy. Replacement ink comes in a sealed transparent plastic inkwell for convenient insertion. Inkwell holds a full 3 ounces, avoiding frequent replacement of ink supply.

28 CHART SPEEDS are available for more versatile recorder application. Fast, convenient changes to any one of the chart speeds may be made by simply changing color-coded gears.

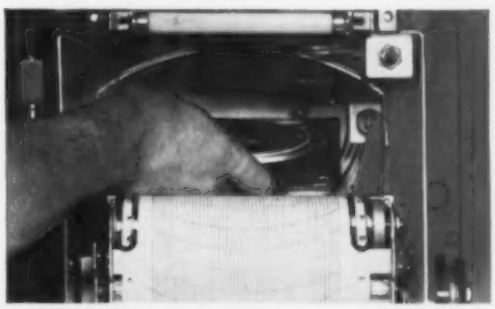
NEW G-E RECORD ROLLS are 1½ times longer than ordinary record rolls. Easier reading comes from light-green ruling in contrast with red recording ink. Faulty chart records are avoided because special paper resists shrinkage and stretching.

A 60-DAY SPRING CLOCK in G-E clock-driven models avoids the need for accessory winding devices. Hand-wound jeweled-spring clock can drive the chart for 60 days at a speed of 1 inch per hour.

NEW DESIGN makes working mechanism easily accessible. Only a screw driver and a socket wrench are needed for normal maintenance. Chart carriage takes less than 60 seconds to remove.

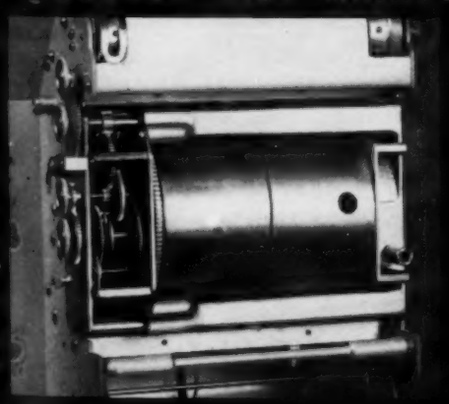


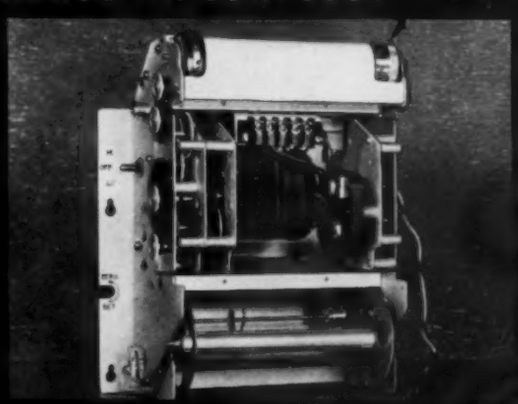
UNIQUE WRITING SYSTEM provides dependable inking with special alloy pen point, spring-loaded pen saddle, and sealed inkwell.



INK REPLACEMENT is fast and easy with sealed inkwell that slips under two spring clamps. Transparent inkwell shows level of ink.

ASSURES EASY MAINTENANCE AT LOW COST





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GENERAL ELECTRIC COMPANY
SCHENECTADY 5, NEW YORK

Please send me the following bulletin:
GEC-1319 General Purpose Recorder, Type CH

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Company.....

Street.....

City.....Zone....State.....

HAND-WOUND SPRING CLOCK chart drives provide 60-day operation at 1 inch per hour with each winding. Chart speeds are from ¼ inch per hour to 30 inches per minute.

CHART CARRIAGE DESIGN allows all maintenance work to be done from the front of the instrument. Entire carriage may be removed in less than 60 seconds by loosening only four screws. Keyhole slots aid quick removal.

FOR FURTHER INFORMATION about the versatile new G-E general purpose recorder, contact your nearest G-E representative, or clip and mail the coupon above.

GENERAL ELECTRIC

DREVER

IMMERSION TUBE HEATED

LEAD QUENCH

FOR WIRE PATENTING

This 3-zone 30 ft. long gas-fired immersion tube heated lead quench forms part of a continuous patenting, cleaning and coating line for high carbon steel wires.

The multi-zoned lead quench is not only heated by gas-fired immersion tubes, but also utilizes the same immersion tubes with forced air cooling to maintain uniform temperatures throughout the bath. A specially designed control system automatically proportions the gas heating and/or air cooling of the tubes.

The quench bath shown above is designed to quench 12 strands of 0.112" dia. high carbon steel wire at a rate of 3000 pounds per hour. The range of quenching temperatures can be varied between 850°F and 1150°F.

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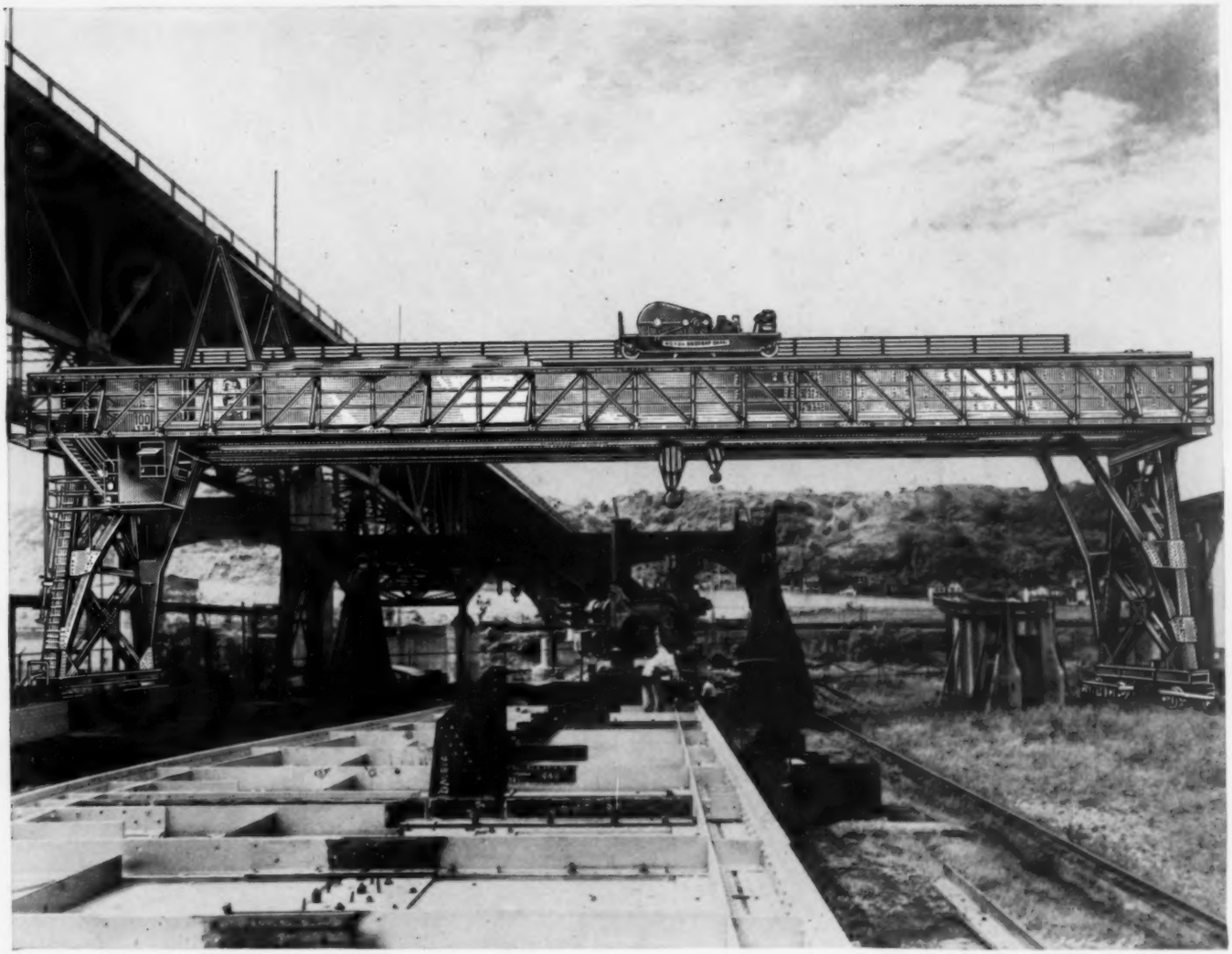

100-ton Bedford gantry crane with 15-ton auxiliary hoist, 130′ span and 30′ lift, owned by a large eastern fabricating plant.

100 Ton Bedford Gantry Crane

This big Bedford gantry crane is equipped with mill type 600 series motors—magnetic dynamic lowering on both main and auxiliary hoists—magnetic reversing plugging control on trolley and bridge motions—Tool Steel Process gears and pinions—eight 36″ straight tread carburized steel bridge wheels. Bridge girders are riveted construction, and each bare girder weighs 92 tons.

All control panels are of the open type, mounted in a walk-in steel control house. Bridge drive is through individual worm drives mounted on each of two bottom bogie trucks controlled by a duplex panel.

The big swing to Bedford Cranes is evidenced by the high percentage of repeat orders from experienced crane users who require and *expect* superior performance.

Backed by more than half a century of *specialized* crane engineering and fabricating experience . . . Bedford Cranes have won fame the world over for advanced design and for safe, smooth dependable performance.

Available in all types and sizes . . . from 5 tons to 350 tons . . . for all kinds of indoor and outdoor service . . . each Bedford Crane is individually engineered for its specific application.

Consult a Bedford engineer on your next crane problem . . . with all the facts on the table we believe you too will make your next crane a Bedford.

Write for complete catalog describing Bedford Cranes in detail

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STEEL FABRICATORS!

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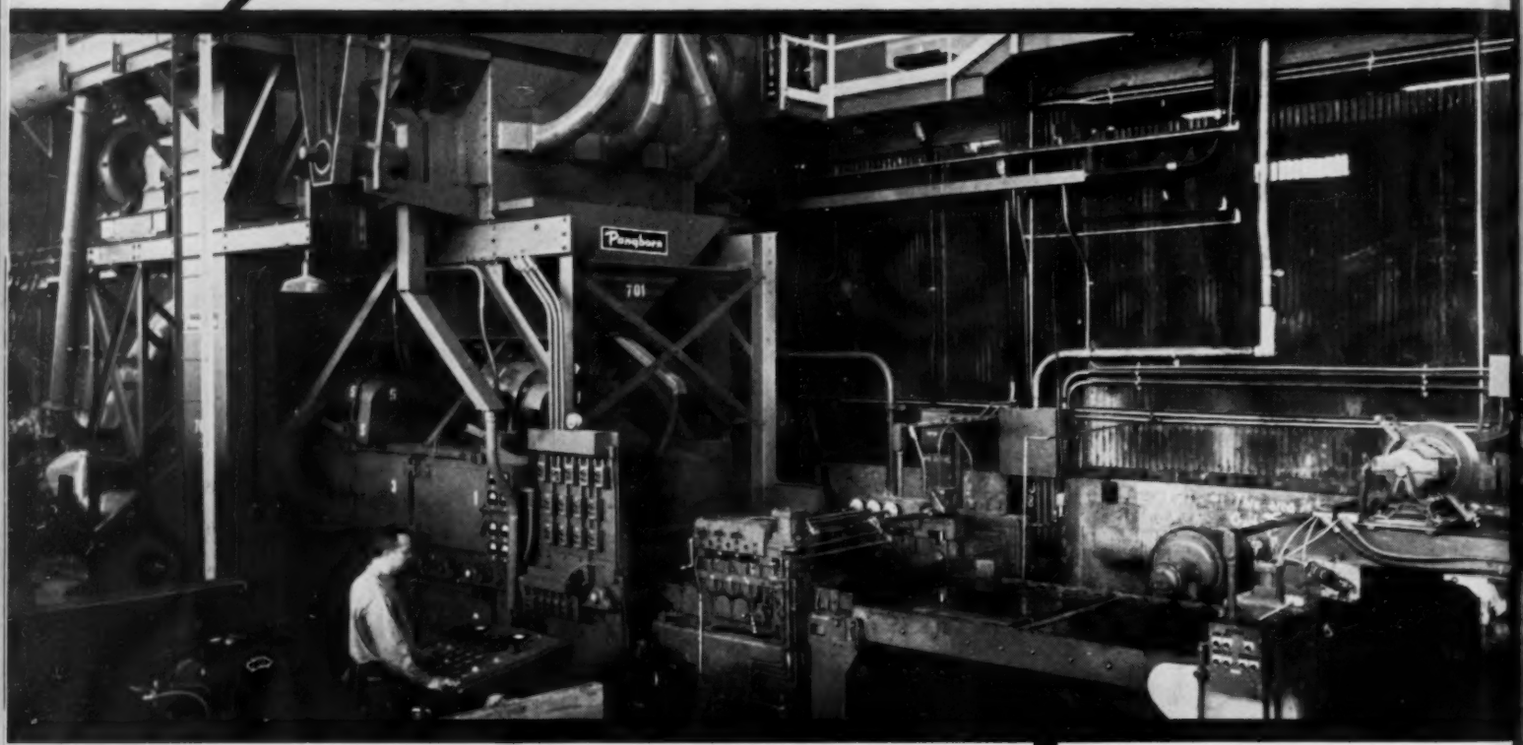
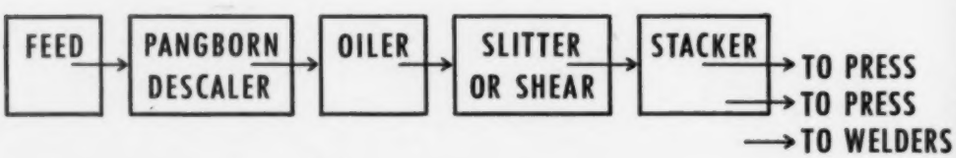


For fabricators using flat steel, coils, cut lengths—Pangborn Rotoblast® Descaling Machines offer *straight line* operation. One feed through descaler, oiler, slitter and stacker!



Here's How You Benefit!

- *You cut costs by using hot rolled unpickled steel.*
- *You speed production.*
- *You reduce labor costs.*
- *You eliminate problem of acid fumes and acid disposal.*
- *You use minimum floor space.*

For full details on automation for fabricators, write for Bulletin Number 224 to Pangborn Corporation, 4400 Pangborn Blvd., Hagerstown, Maryland.

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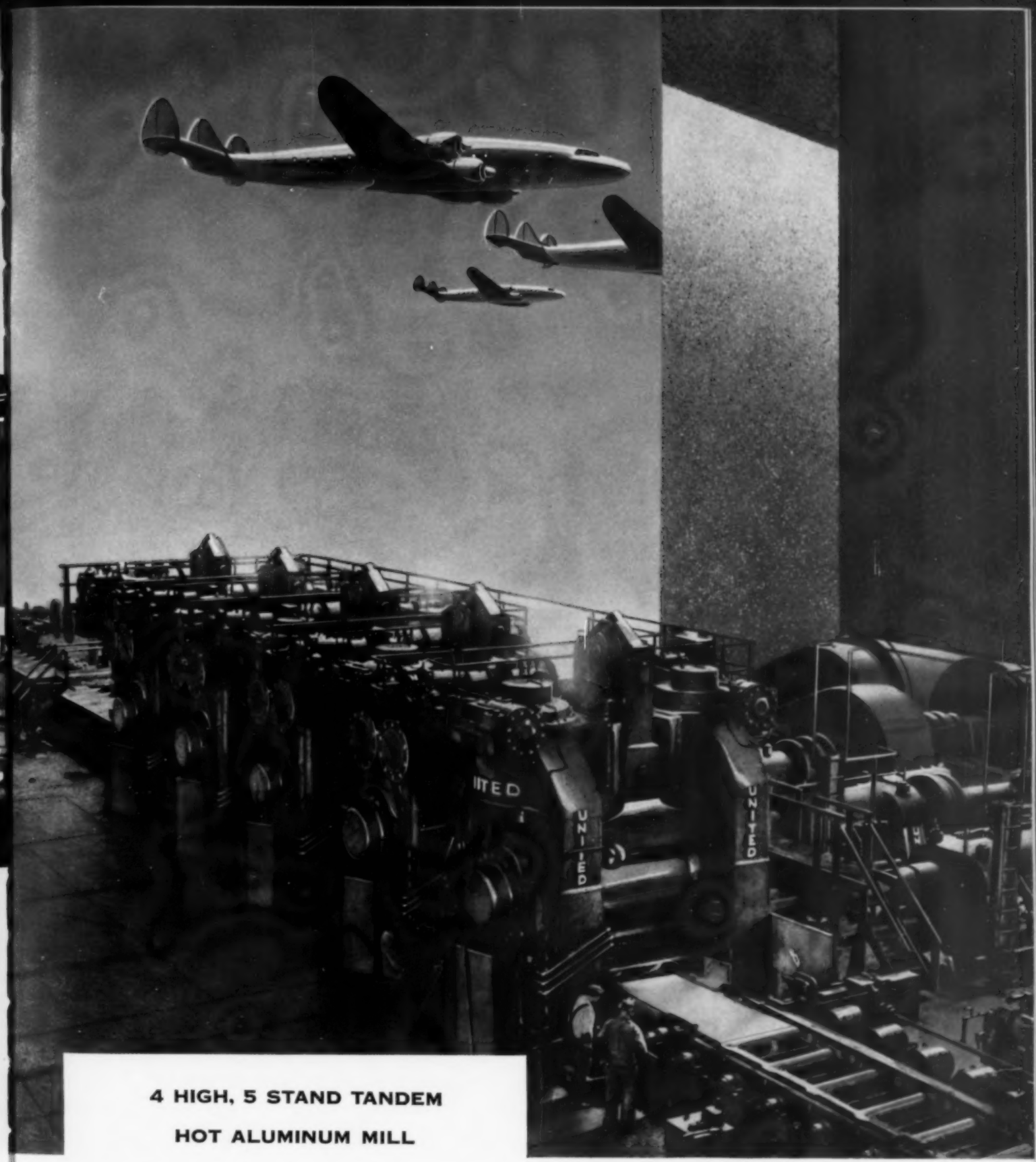

4 HIGH, 5 STAND TANDEM

HOT ALUMINUM MILL

Designed and Built by

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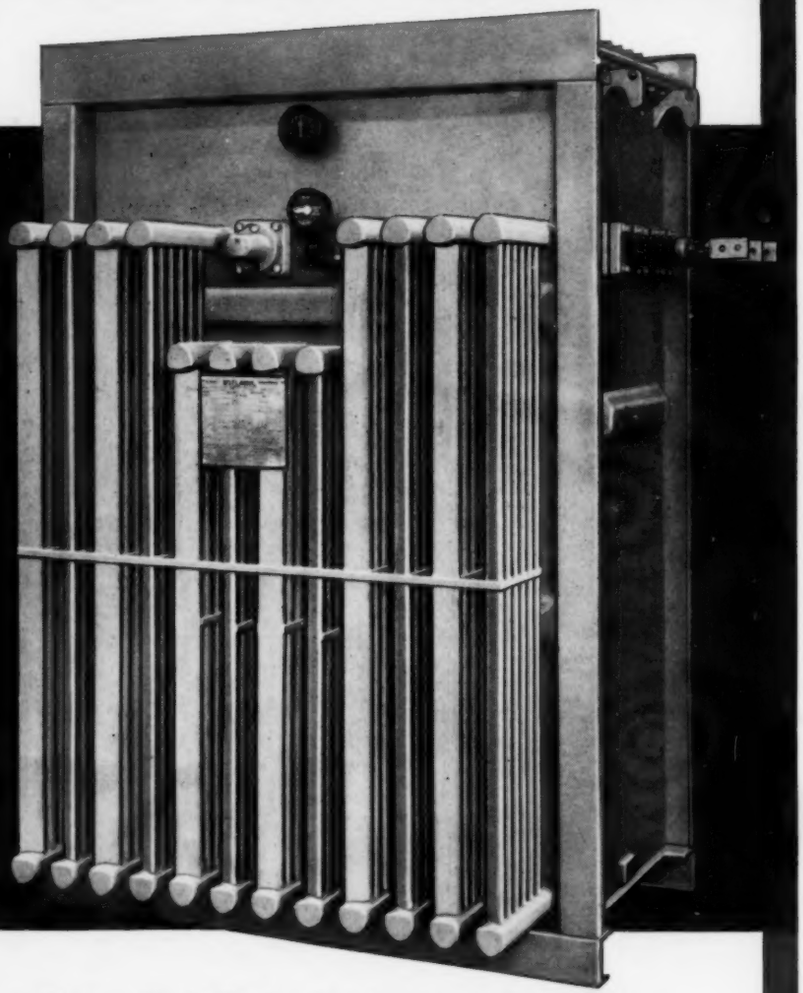
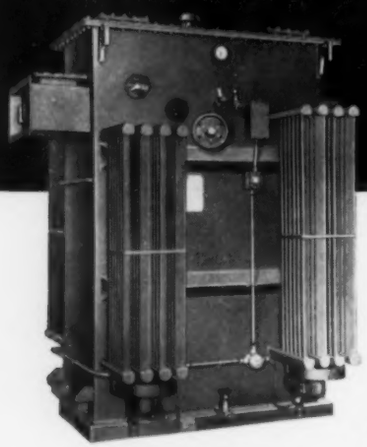
TRANSFORMERS
... the choice of leaders in industry

for space-saving load centers... specify Wagner Close-Coupled Unit Substation Transformers





Wagner

THROAT-CONNECTED UNIT SUBSTATION TRANSFORMERS

For outdoor installation, or for applications where it is desirable to locate the transformer away from the switchgear, Wagner can furnish these liquid-filled transformers in ratings to 2000 kva, 15 kv and below. Bulletin TU-13 gives full information.

Now, Wagner liquid-filled unit substation transformers are available in new, improved close-coupled units, rated from 300 to 2000 kva, that can be flush-mounted with any make of switchgear. They can be used in both single and double-ended unit substations to form neat, compact, streamlined substations for modern industrial service.

Bushings are provided on the ends of the close-coupled transformer for connection to the switchgear. The bushing heights are designed for a minimum distance from the base, giving ample room to make connection to switchgear or busses in the switchgear compartment or transition section.

In this type design it is not necessary to coordinate bushing height of transformer and switchgear as in the throat connected units which often require special throat heights to match special switchgear. This feature means that a standard transformer can be used for special switchgear application with a minimum of engineering coordination, resulting in shorter deliveries.

Look to Wagner for better transformers that assure a continuous, dependable flow of power. Your nearby Wagner engineer will be glad to help you solve your load-center problems. Call the nearest of our 32 branch offices, or write us.

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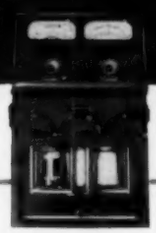
T55-2

THIS IS INLAND STEEL!

The Cities Service Heat Prover Works Here



THE PORTABLE HEAT PROVER is supplied and maintained free by Cities Service. It helps control combustion efficiency by allowing rapid, continuous sampling, simultaneous readings and direct measurement of oxygen and combustibles. Inland uses the Heat Prover for its blast furnaces, open hearths, soaking pits, continuous galvanizing line, reheat furnaces, purging operations, annealers, and boilers on ore ships.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

TIMKEN® TQIT roll neck bearings in new United 4-hi, 4-stand mill give interference fit with easy removal

ALAN WOOD Steel Company's new 4-hi, 4-stand tandem cold reduction mill, built by the United Engineering and Foundry Company, uses Timken® 4-row tapered bore tapered roller bearings on the back-up rolls.

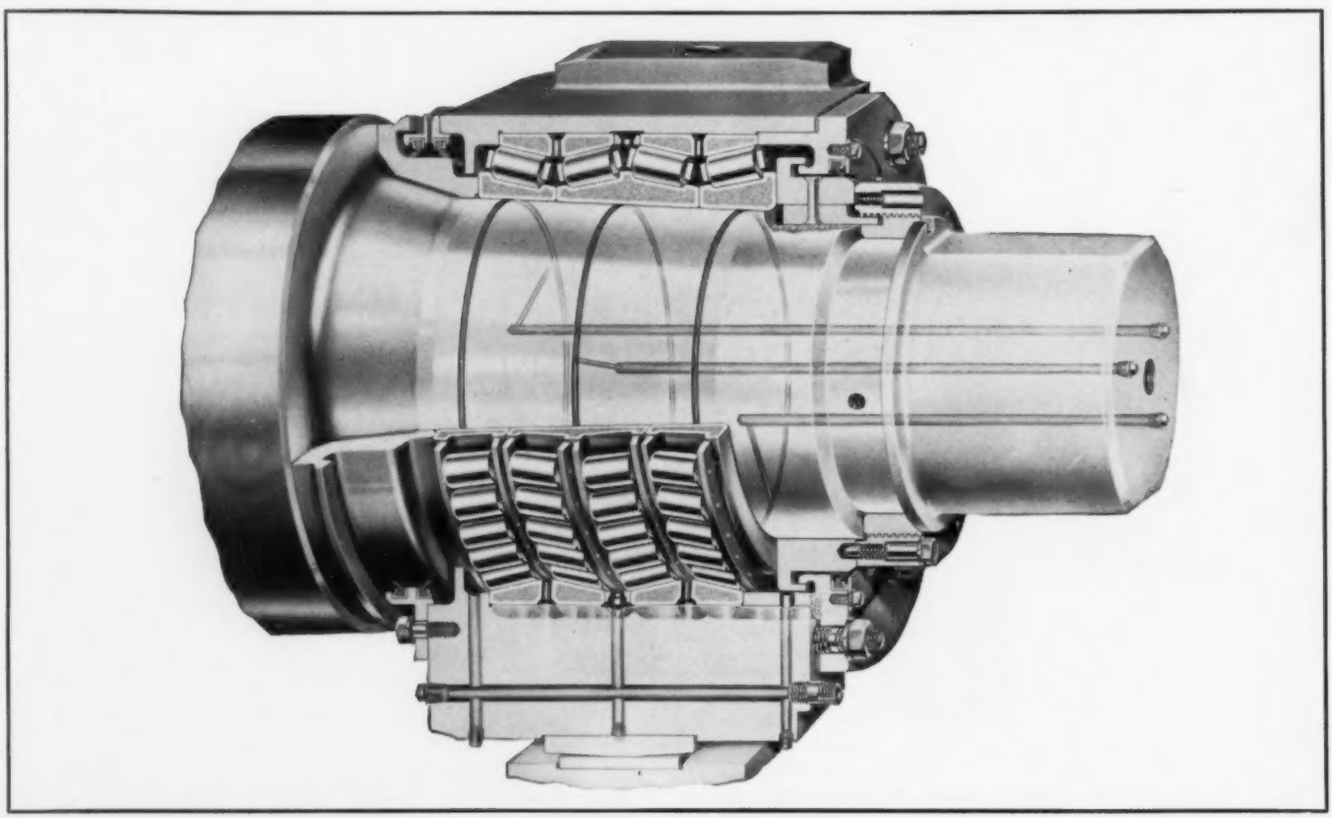
This new roll neck bearing combines maximum bearing capacity and interference fit with easy removal. It can be quickly removed from the roll neck by expanding its cones hydraulically. Excessive scuffing and neck wear are eliminated. The interference fit of the cones with the roll neck provides greater stability between cones and roll neck and gives better load distribution within the bearing. It also permits improved fillet contours and larger necks. Result: lower neck stress and deflections than any other arrangement.

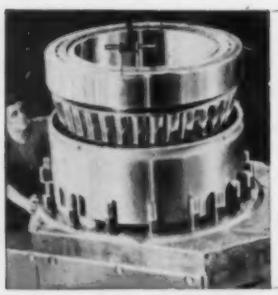
Timken bearings use economical grease lubrication. There's no loss of lubricant during roll changes. Rolls can be changed faster because there are no pipes or tubes. And there's no need for special thrust bearings because the tapered construction of Timken bearings lets them take radial and thrust loads in any combination.

With Timken bearings, higher mill speeds are possible, and starting resistance is reduced to a minimum so there's no roll scuffing or scoring of steel. That's because Timken bearings practically eliminate friction—design, by geometrical law, gives them true rolling motion . . . and they're made extremely accurate to live up to their design.

Get all the advantages of the Timken TQIT bearing in your mill. For more information, write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.





ROLL NECK BEARING ENGINEERING SERVICE

Our field and service engineers have had years of experience with problems of roll neck bearing design and operation. They'll help you select bearings and design mountings.

The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis Timken steels.

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TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ↓ AND THRUST → LOADS OR ANY COMBINATION ↔

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Patent Reviews

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each . . . . patents reviewed cover period May 24, 1955 through June 15, 1955 . . . .

PRODUCTION OF MANGANESE AND IRON CONCENTRATES FROM OPEN HEARTH SLAG

▲ U. S. 2,709,131, issued May 24, 1955 to William E. Marshall and assigned to Armco Steel Corp., provides a method of producing concentrates of manganese and of iron, suitable for use in the production of steel, from open hearth furnace slags.

The process is shown in Figure 1. Slag is fed from a hopper 4 by a screw 5 into the top of the treatment furnace 1. The upper part of the furnace is provided with an electrical heater 7 to maintain a temperature of 1500 F. In this part of the furnace, the slag is treated with hydrogen, to remove as much oxygen as possible. The hydrogen is admitted to the shaft through line 8 by means of a pump 9, and the exit gases leave the top of the furnace through line 10 and pass to a condenser 11. The steam is condensed here to water, the hydrogen being recovered for re-use.

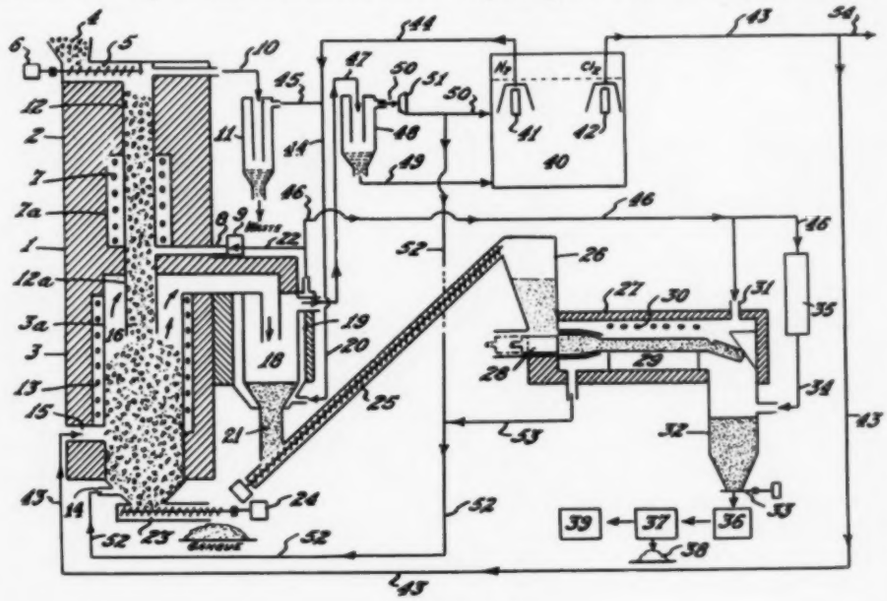


Figure 1

In the lower part of the furnace 3, the iron and the manganous oxide are converted by a mixture of hydrogen and hydrogen chloride gas to ferrous and manganous chlorides. Hydrogen and hydrogen chloride gas are admitted through line 14, and some additional chlorine is added through line 15, reacting immediately with part of the hydrogen. The lower part of the furnace is operated at a temperature of 1600 to 1800 F.

The chlorides vaporize, and the vapors pass into a collection space 16 above the mass of slag in the lower part of the furnace, and then into a condenser 18. The condenser has a jacket 19 through which the incoming hydrogen for the upper part of the furnace is introduced through line 20. The resulting cooling causes the condensation of the ferrous and manganous chlorides, which collect at the bottom at 21.

The slag leaving the bottom of the furnace is removed through a screw 23.

The ferrous and manganous chlorides are carried by screw conveyor 25 from the condenser 18 to the hopper 26 of a horizontal furnace 27. This furnace is provided with a plunger feeder 28 and a hearth 29. Heating elements 30 are provided. Hydrogen is introduced into the furnace through a line 31. The operating temperature is about 1100 F. The chlorides are converted to iron and to manganous oxide. These collect in a hopper 32. Some hydrogen, which has been dried by passage through a dryer 35, is passed through line 34 into the collection hopper, in order to protect the iron from reoxidation while cooling.

The material from the gate 33 passes to a crusher 36 and then to a magnetic separator 37, from which relatively pure powdered iron and manganous oxide are recovered.

The requirements for hydrogen in the process are satisfied by an electrolytic cell 40, which produces hydrogen and chlorine for use in the process.

Excess hydrogen and hydrogen chloride from the chloride condenser 18 passes through line 47 to a condenser 48, where an aqueous solution of HCl is condensed and delivered to the electrolytic cell 40. Uncondensed hydrogen and hydrogen chloride are also fed from condenser 48 to the cell 40 in such a position that the hydrogen will be collected at the hydrogen electrode, while the hydrogen chloride will react with the sodium or calcium hydroxide generated in the cell.

METHOD AND APPARATUS FOR PICKLING AND FOR RECOVERING SPENT ACID SOLUTIONS

U. S. 2,709,143, issued May 24, 1955 to Charles B. Francis and Edmund Lynch, and assigned to United

States Steel Corp., describes a continuous process for pickling and recovery of the spent acid solution.

As shown in Figure 2, a coil of steel S is uncoiled prior to pickling. Next to the uncoiler 2 are the bridle rolls 4 which feed the strip to a welding machine 6 where the trailing end of one strip is fastened to the leading end of a following strip. From here the strip passes to a looper pit 8 and then to

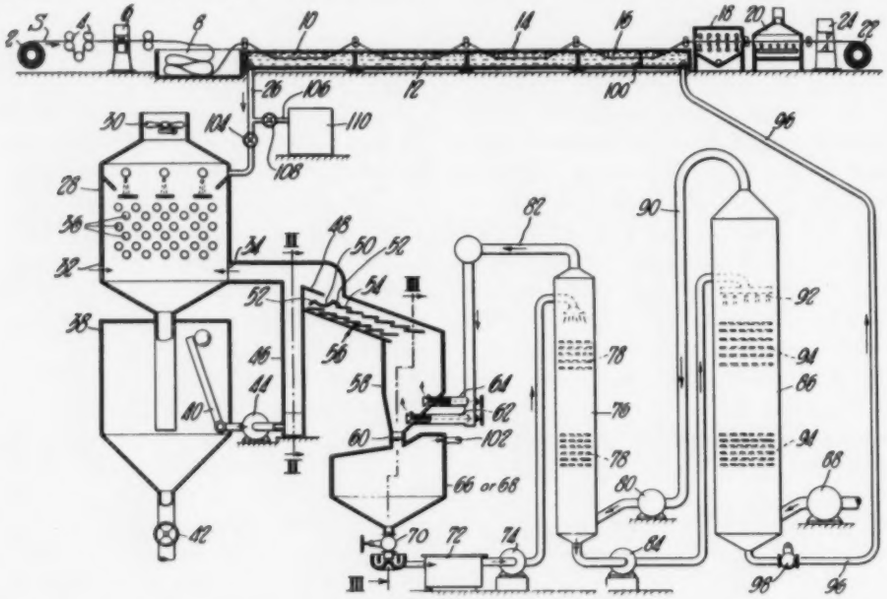


Figure 2

a series of pickling tanks 10, 12, 14 and 16. Acid is washed from the strip in the rinse tank 18, and the strip is then dried in the drier 20 prior to recoiling on the coiler 22. A shear 24 is provided to cut the strip into the desired length.

The acid flows from the tank 16 to tank 10, fresh acid being introduced into tank 16. The waste pickle liquor is removed from tank 10 and delivered to the top of a cooling tower 28. Air inlets 32 and 34 are provided at the bottom of the cooling tower. Below the cooling tower is a surge tank 38. The waste pickle liquor drops to the bottom of the surge tank and is withdrawn from the floating outlet of a rubber tube 40. The acid leaving tank 10 is at 180 to 250 F, and it is cooled in the cooling tower to about 100 F, high enough to keep ferrous sulphate from crystallizing out.

From the tube 40, the cooled solution is pumped to a feed tank 46 whose top is open to the air line 34. A weir and liquid apron 48 is provided at the top of the feed tank 46, and the waste pickle liquor flows over the weir into a distributing trough 50. The design of this trough is given in some detail in the patent. A current of cool air passes over the waste pickle liquor as it flows down the trough. The liquid drops down to a vertical tank 58 at a temperature of 70 F or lower. Air at —100 F is admitted through nozzles 62 and 64, the nozzles being submerged in accumulated liquid, thereby helping to cool the solution very rapidly. As a result, a large part of the ferrous sulphate separates as very fine crystals.

Below the cooler 58 are crystallizing tanks 66 and 68, into which the cooled solution flows continuously. The liquid and crystals withdrawn from the bottom of the crystallizing tanks are passed alternately to two centrifuges 72. The cold mother liquor is then pumped to the top of a heat exchanger 76 at 25 to 30 F. Compressed air is delivered by compressor 80 to the bottom of this heat exchanger, up through it, and then to the trough 50.

The liquid is then pumped to the top of a second heat exchanger 86, through which the compressed air also travels, being compressed by compressor 88. The solution leaves at about 80 F, containing 6 to 8 per cent of ferrous sulphate and 8 to 10 per cent sulphuric acid, and is ready for recycling. Make-up acid and steam are added in tank 16, along with the recycled liquor.

TAP HOLE MIX

U. S. 2,709,659, issued May 31, 1955 to Leroy C. Werking and assigned to Union Carbide & Carbon Corp., and U. S. 2,709,660 issued the same date to Howard L. Larson and Lester L. Winter, and also assigned to Union Carbide & Carbon Corp., describe tap hole mixes to be used for plugging the tap holes of blast furnaces.

In the first patent, the mix consists preferably of clay and a thermosetting resin-forming carbonizable binder such as a mixture of tar and furfural. The mixture is waterfree. According to Werking, this mix avoids the destruction of carbon in the vicinity of the tap hole, which ordinarily takes place by reaction with water in the mix and with oxygen from the oxygen lance. Since no water is used, and since carbon is deposited from the mix, the carbon lining of the furnace is unaffected.

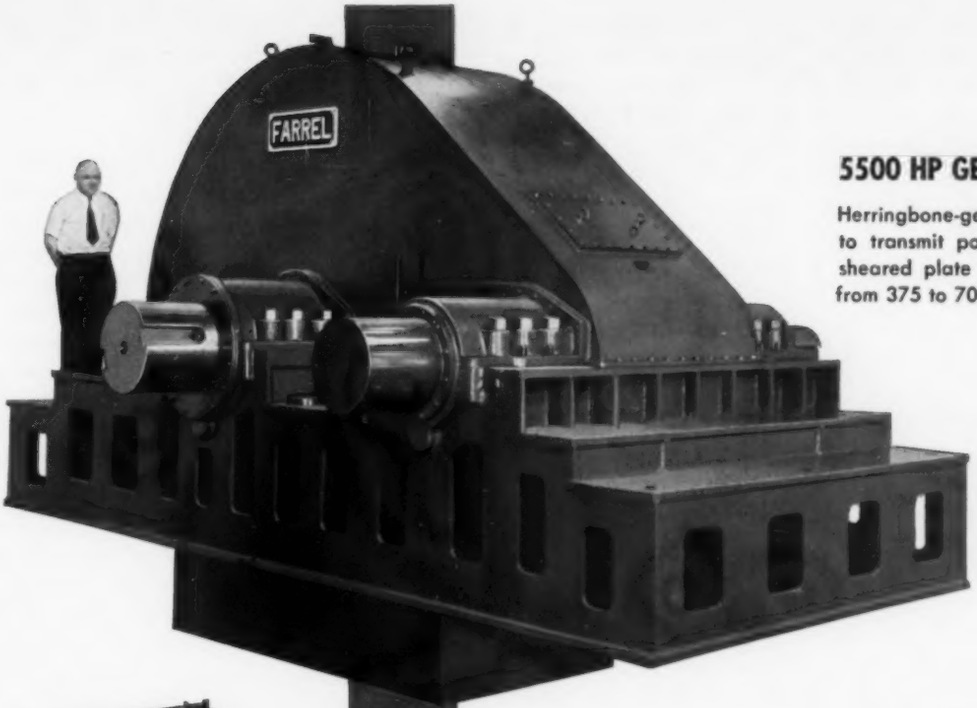
In the second patent a conventional refractory mix is used, containing water, but a small amount of a water-soluble vaporizable organic compound is added. Apparently the hydrocarbon vaporizes in the furnace, providing a reducing atmosphere, and also carbonizes, and the carbon so produced reacts preferentially with the steam evolved from the mix.

DEVICE FOR STRAIGHTENING SEAMLESS TUBING

U. S. 2,709,935, issued June 7, 1955 to Gunnar Sanderson and assigned to United States Steel Corp., describes a device for straightening short irregularities which are not corrected by usual straightening equipment.

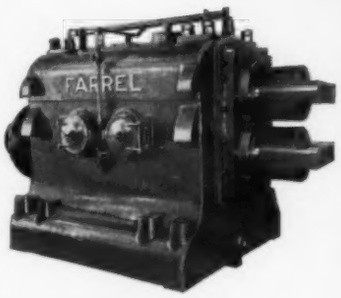
In Figures 3, 4, and 5, the last stand 10 and the next to the last stand 11 of a sizing mill are shown, with tubing 12 passing through the mill from left to right as seen in Figure 3. Stand 10 includes a housing 13 and grooved power driven rolls 14 and 15. Stand 11 includes a housing 16 and rolls 17 and 18, with their axes perpendicular to those of rolls 14 and 15.

A straightening device 20 is mounted in the space between the stands 10 and 11. It consists of a sleeve 21 supported on housing 13 of the last stand 10 for limited angular movement being unsupported at its end near stand 11. The sleeve bore has a close tolerance over the outside of the tubing. The end of the sleeve bore is flared at 31.



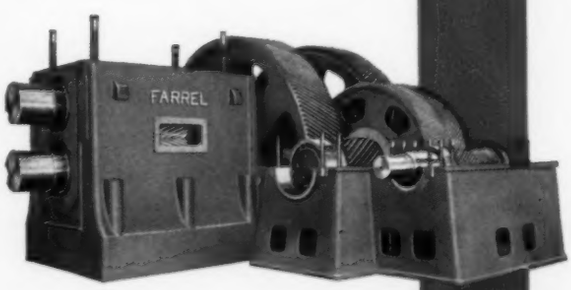
5500 HP GEAR DRIVE

Herringbone-geared reduction unit designed to transmit power to a 134" three-high, sheared plate mill, reducing motor speed from 375 to 70.35 RPM.



2000 HP PINION STAND

21" pinion stand designed to transmit power to a four-high aluminum sheet mill. The heat-treated, forged steel pinions are continuous-tooth herringbone, generated by the Farrel-Sykes process.



2000 HP COMBINATION UNIT

Built to transmit power to a two-high, cold brass, breakdown mill, this combined drive and pinion stand has first reduction gears and mill pinions of the Farrel-Sykes herringbone type, while the second reduction gears are split (divided) double helical.

Every FARREL MILL DRIVE is individually designed

Power and speed, type and gauge of metal to be rolled, process (hot or cold), nature of load (continuous or intermittent), type of drive motor—all are taken into account before the size, material and type of construction are specified.

This development of a Farrel unit, whether it is a gear drive, pinion stand, or combination, assures optimum efficiency, plus the inherent strength to withstand the shocks, stresses and wear encountered in continuous, heavy-duty service.

Herringbone, single helical, or a combination of single and double helical gears may be furnished for gear drives. Mill pinions are usually herringbone type, although single helical pinions can be supplied. These gears and pinions are precision-generated by the famous Farrel-Sykes process, assuring accuracy of tooth spacing, profile and helix angle, resulting in high efficiency, and smooth, quiet operation.

Send today for information on these individually engineered mill drives. Or, if you prefer, a Farrel engineer will be glad to discuss your drive problems with you.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N.Y.
Sales Office: Ansonia, Buffalo, New York, Akron, Pittsburgh, Chicago, Fayetteville (N. C.), Los Angeles, Houston

FB-990

Farrel-Birmingham®

In operation, tubing passing through the mill passes through the bore of sleeve 21. Short irregularities, of length up to bore length, are thus ironed out. Since these irregularities are eliminated before the tubing enters the last rolls, no fins or shear marks are produced.

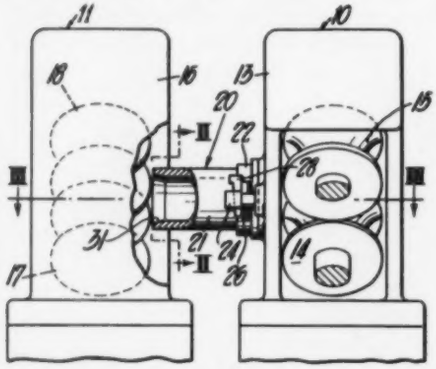


Figure 3

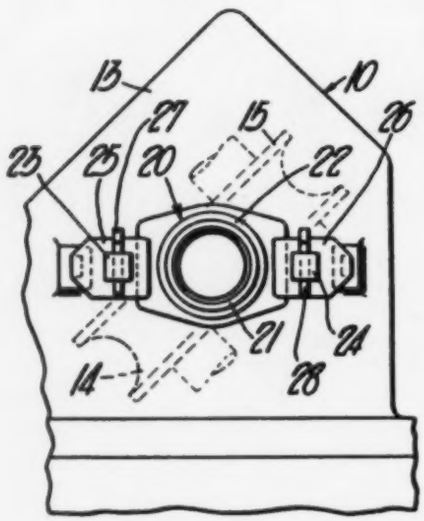


Figure 4

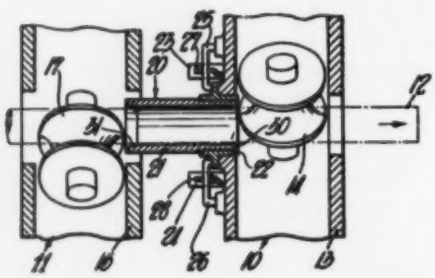


Figure 5

HOLD-DOWN DEVICES FOR SIDE TRIMMING SHEARS

U. S. 2,710,062, issued June 7, 1955 to Carl T. Lanstrom and assigned to United States Steel Corp., describes improved hold-down devices for side trimming shears, which engage the strip closely at its edges to furnish proper holding action, and yet eliminate the possibility of scratching the strip surface.

The devices contain adjustable wheels which engage the upper faces of the strip near its outer edges. Any particles caught on the wheel surfaces will at most dent the strip surfaces without scratching it, and the particles can easily be removed.

APPARATUS FOR CLEANING OPEN-HEARTH FURNACE CHECKERS

U. S. 2,710,225, issued June 7, 1955 to Edwin R. Richards, and assigned to United States Steel Corp., describes apparatus for cleaning the checkers of open hearth steelmaking furnaces.

The apparatus includes a lance for introducing compressed air or steam. The lance is mounted on a trolley, and is power-driven in such a manner that it may easily be moved from point to point to clean one portion after another of the checkers.

TIN POT OIL COMPOSITION

U. S. 2,710,272, issued June 7, 1955 to Willard O. Cook and assigned to United States Steel Corp., describes a cheap substitute for palm oil as a tin pot oil composition for the hot-dip tinning of steel.

A mixture of a mineral oil and about 10 per cent of a fatty oil such as palm oil is made, and to this is added about 1 per cent of a chloride salt such as stannous chloride.

According to the inventor, this composition is the equivalent of palm oil, but is much cheaper and possesses a longer active life than straight palm oil.

DEVICE FOR PROTECTING BLAST FURNACE LININGS

U. S. 2,710,747, issued June 14, 1955 to James A. Shea and assigned to United States Steel Corp., describes a device for protecting blast furnace linings from damage at the stock line.

The device consists of a number of interconnected vertical lightweight grids which are freely suspended over the stock line and which upon heating, expand tightly against the furnace lining, thereby protecting it from abrasion. The advantage of this device is that it is easy to install and remove.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,708,958	5/24/55	Method and apparatus for making a steel floor	H. H. Robertson Co.
2,709,009	5/24/55	Cupola charging device	Herbert A. Reece and Chester A. Hartman
2,709,110	5/24/55	Apparatus for coating the interior of an ingot mold	United States Steel Corp.
2,709,132	5/24/55	Corrosion and wear-resistant ferrous alloys	Latrobe Steel Co.
2,709,142	5/24/55	Cleaning metal strip	Metals & Controls Corp.
2,709,284	5/31/55	Continuous casting	Babcock & Wilcox Co.
2,709,530	5/31/55	Furnace feeding apparatus	Oglebay, Norton & Co.
2,709,627	5/31/55	Horizontal roll stand	Birdsboro Steel Foundry and Machine Co.
2,709,650	5/31/55	Method of processing iron-containing materials to nodules	Friedrich Johannsen
2,709,677	5/31/55	Heating devices and heat regenerators for coke ovens	Compagnie Generale de Construction de Fours
2,709,934	6/ 7/55	Rolling mill	Franz Platzer
2,710,104	6/ 7/55	Apparatus for charging billet heating furnaces	United States Steel Corp.
2,710,182	6/ 7/55	Sintering furnace plow	Cecil B. Shelton
2,710,183	6/ 7/55	Expandable wind box structure for sintering machines	Koppers Co., Inc.
2,710,281	6/ 7/55	Reversing machines for regenerative Coke ovens	Koppers Co., Inc.
2,710,433	6/14/55	Continuous casting machine	Ilario Properzi
2,710,502	6/14/55	Method of buffing wrought stainless steel	George A. Lyon
2,710,589	6/14/55	Apparatus for oiling metal strip	Jones & Laughlin Steel Corp.
2,710,663	6/14/55	Removal of naphthalene from coke oven gas	United States Steel Corp.
2,710,748	6/14/55	Cupola furnace provided with an ash collector	Edward T. Douglas, Jr.
2,710,778	6/14/55	Bearing chocks for rolling mills	United States Steel Corp.

The choice of leading mills for back-up roll bearings

. . . GULF I-C OIL

Several years ago Gulf I-C Oil was selected to lubricate the back-up roll bearings of the world's fastest cold strip mill at U. S. Steel's Fairless Works. Today it is still doing an outstanding job of providing effective protection as the strip shoots through the rolls at speeds up to 7000 feet per minute.

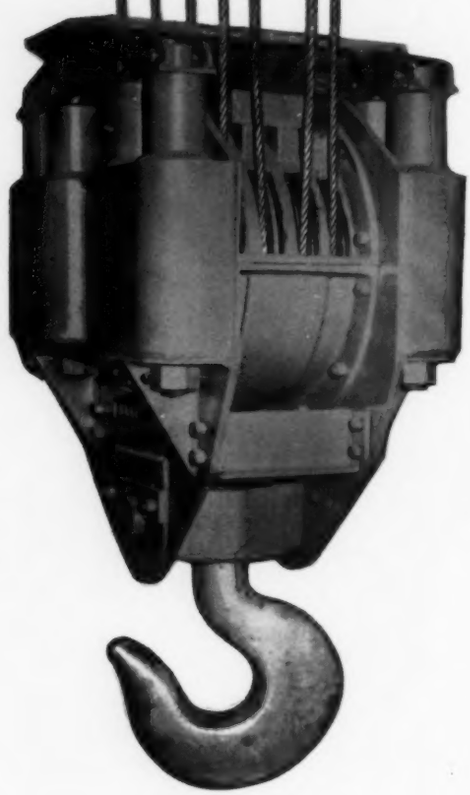
Gulf I-C Oil has excellent stability, resists emulsification and sludging, plus rapid water separating characteristics. These properties keep bearings and oil lines clean, contribute to longer bearing life, trouble-free performance, and lower maintenance costs.

So when you next order a roll-bearing lubricant, make it an order for dependable, efficient lubrication by specifying Gulf I-C Oil. Contact your nearest Gulf office and have a Gulf Sales Engineer recommend the proper grade for your equipment. Gulf Oil Corporation · Gulf Refining Company, 1822 Gulf Building, Pittsburgh 30, Pa.

GULF

THE FINEST PETROLEUM PRODUCTS FOR ALL YOUR NEEDS

This accident could have been prevented by using Alliance SAFETY HOOK BLOCK



Cables break and hook blocks fall when the block is run against the lifting beam of a crane at high speed. THIS DOES NOT OCCUR WITH ALLIANCE SAFETY TORQUE HOOK BLOCKS. Design features prevent it.

Each Alliance hook block is fitted with springs of sufficient capacity to cushion the impact of the block on the upper lifting beam. Before the springs come into action a plunger trips the circuit breaker, thereby disconnecting the motor. The springs then bring the hoist mechanism to a stop even before the hoist brakes are set. The Alliance Safety Hook Block can be installed on most existing cranes. Write for full information. You or your engineers can see an actual demonstration of this Alliance Safety Hook Block in our plant at any time . . . a short movie is also available. Let us help you eliminate tragic shop accidents. This is one of Alliance's contributions to safety in industry.

World's Largest Builders of World's Largest Cranes

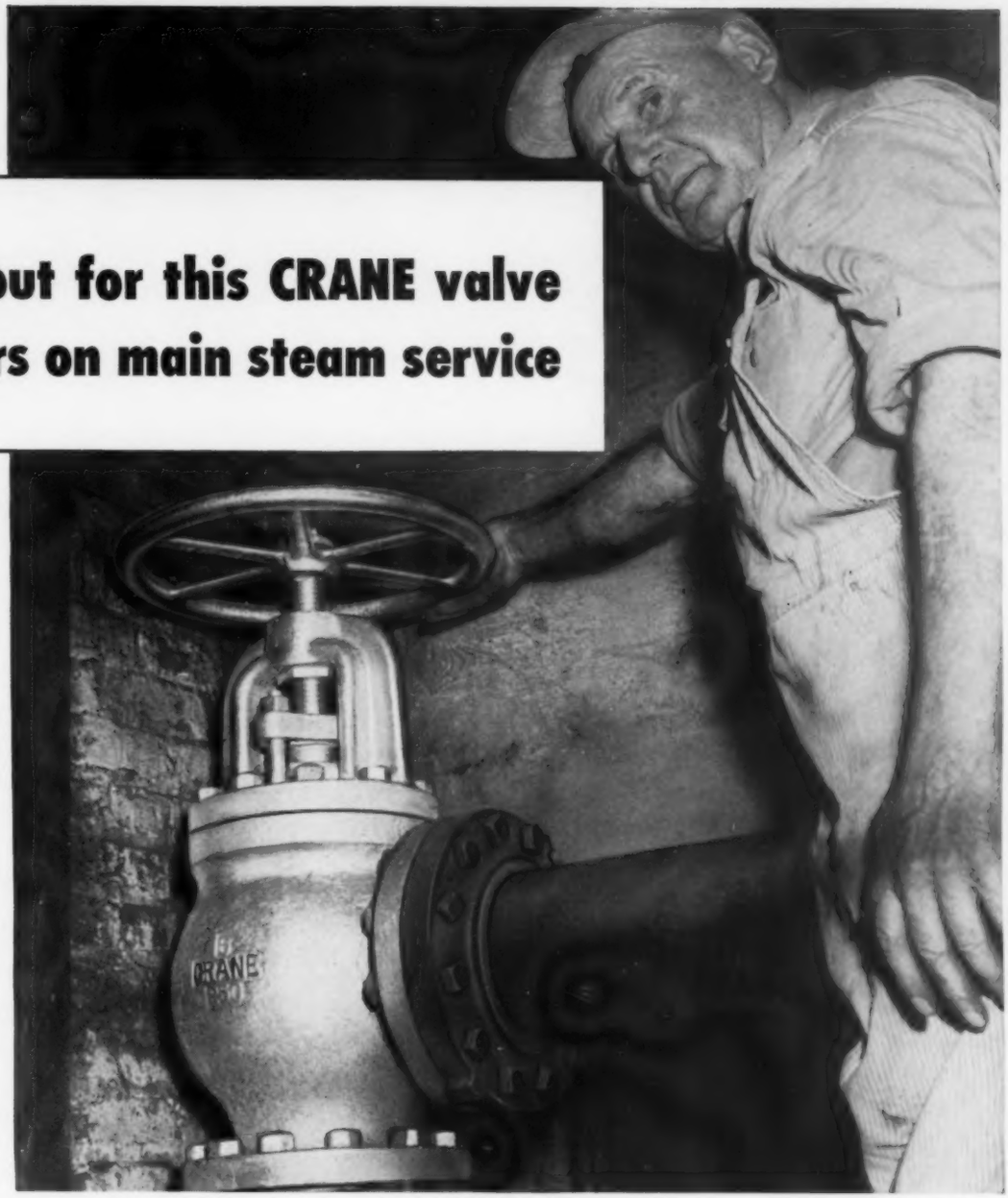
Give Us the Runway and We'll Lift the World

THE *Alliance* MACHINE COMPANY

Alliance, Ohio

LADLE CRANES · GANTRY CRANES · FORGING MANIPULATORS · SOAKING PIT CRANES · STRIPPER CRANES · SLAB AND BILLET CHARGING MACHINES · OPEN HEARTH CHARGING MACHINES · SPECIAL MILL MACHINERY · STRUCTURAL FABRICATION · COKE PUSHERS

No time out for this CRANE valve in 40 years on main steam service



THE CASE HISTORY—Two Crane 250-pound iron body angle valves—6-inch (shown) and 5-inch size—scored this exceptional service record.

They were installed in 1915 on the main steam leads from boilers in the plant at Delavan, Wis., now occupied by The George W. Borg Corporation. In 40 years' uninterrupted service these Crane valves never failed to operate properly nor caused a shutdown. With but routine maintenance, they opened fully and were seated tight with ease under infrequent operation. Working pressure of boilers was originally 150 psi.—later reduced to 75 psi. This year, both valves were retired. The new replacements are Crane quality valves, of course.

Crane iron valves in particular need no introduction to thrifty buyers. In all grades, Crane iron castings generously exceed the requirements of equivalent A.S.T.M. specifications. Crane Ferrosteel, for instance, used in 250-pound valves is 35% stronger than ordinary cast iron.

In any pressure class, you'll find Crane quality outstanding. Choose from complete lines of gates, globes, angles and checks. Your Crane Representative can give valuable help in specifying and ordering.

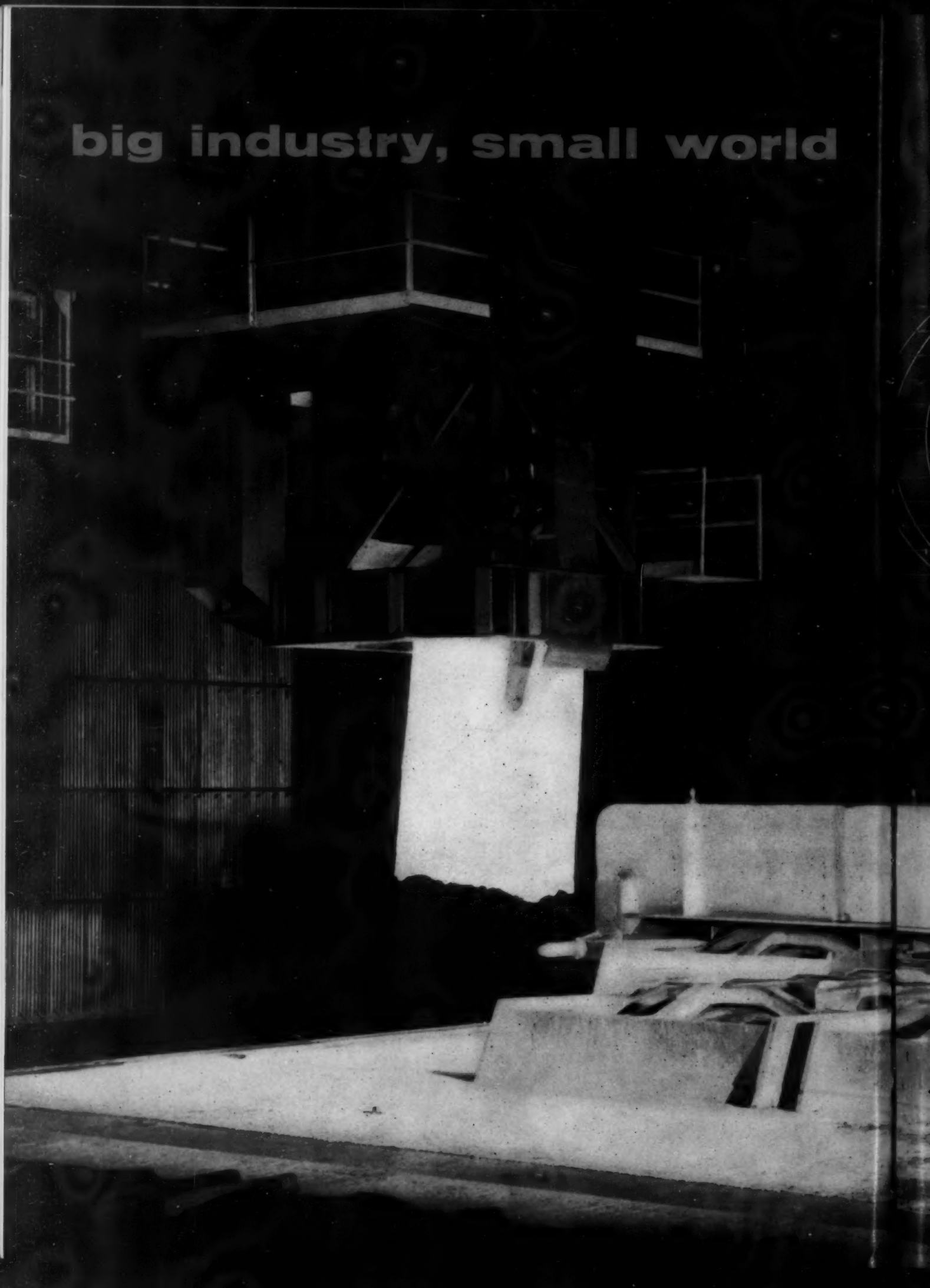
Crane Co., General Offices, Chicago 5, Ill. Branches and Wholesalers serving all industrial areas.

CRANE CO.

VALVES • FITTINGS • PIPE
KITCHENS • PLUMBING • HEATING

CRANE'S FIRST CENTURY...1855-1955

big industry, small world

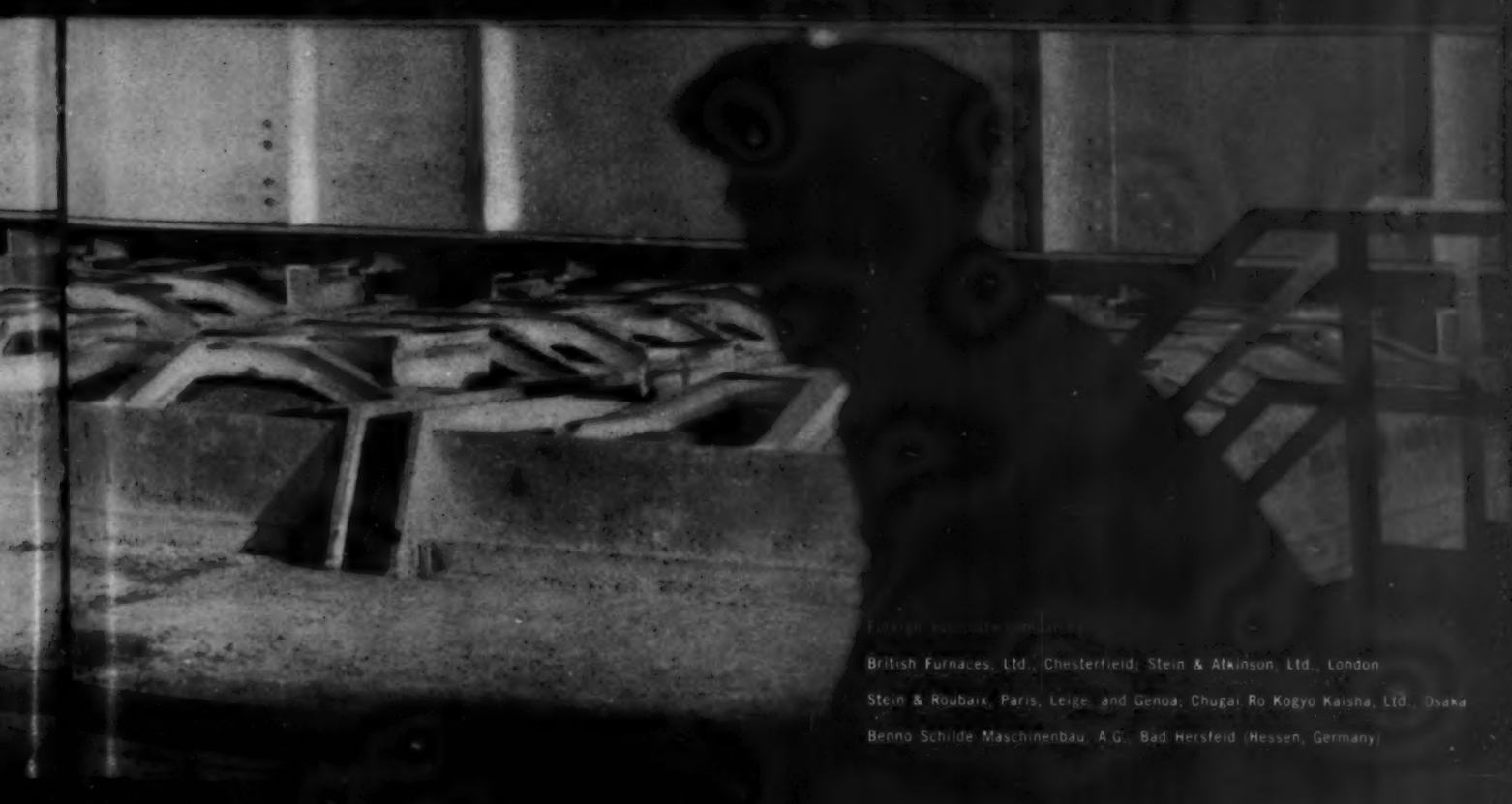


annealing covers
billet reheating furnaces, continuous
carbon restoration and annealing furnaces, continuous
controlled atmosphere generators
high-speed stress relieving furnaces
one-way fired soaking pits
pit-type annealing furnaces
slab and billet heaters, continuous
strip annealing furnaces, continuous
strip galvanizing lines, continuous
wire patenting furnaces, continuous

Wherever this steel goes—from first soak to final shipping dock—it will find that the big steel industry is a small world as far as 'Surface' equipment is concerned. Somewhere along the line, whatever its destined shape, the steel will be made more workable and more useful in 'Surface' furnaces.

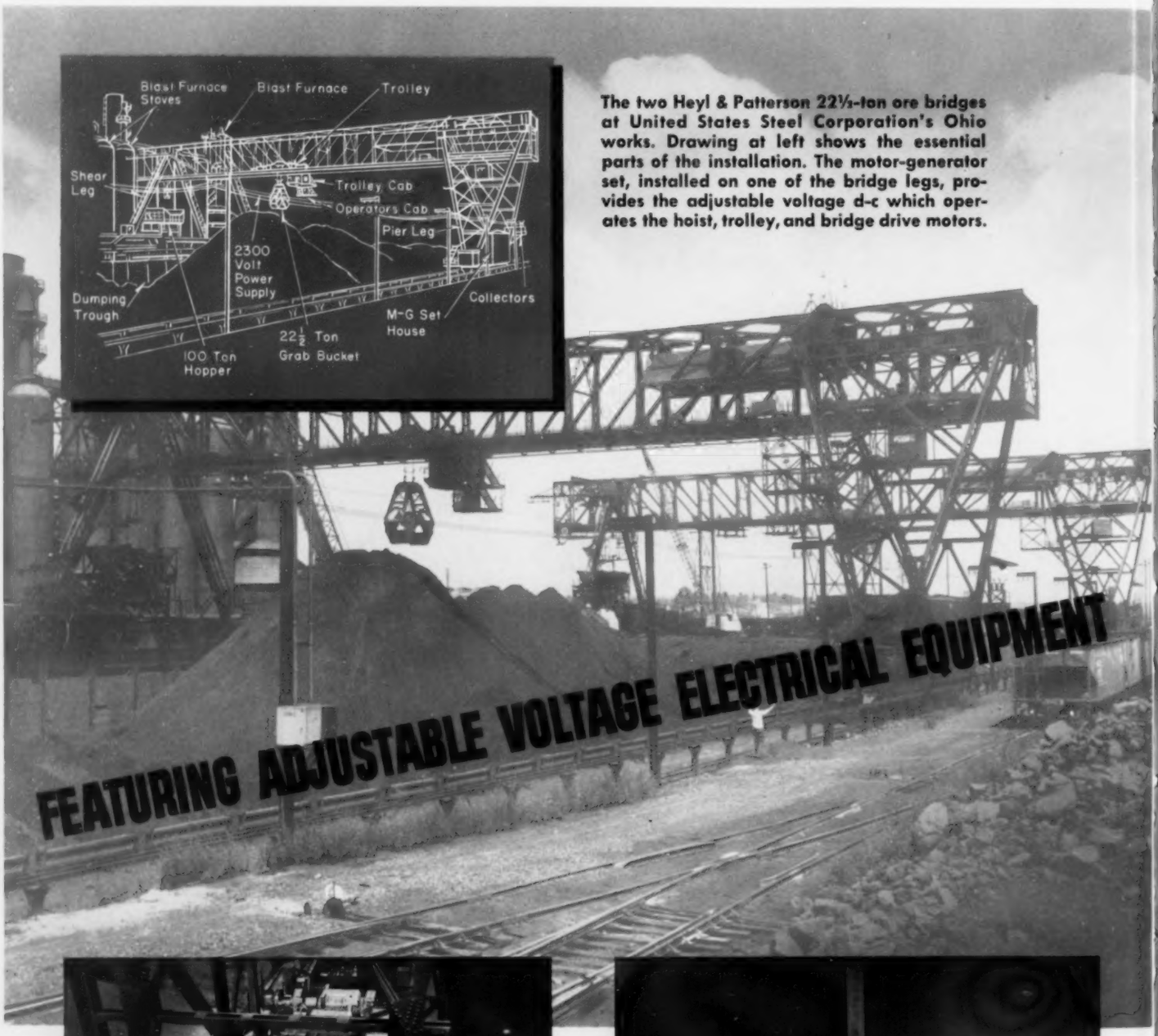
Why is it so easy to bump into 'Surface' in steel mills? One reason is that 'Surface' has literally grown up with the steel industry. A better reason is the confidence that steelmakers have in the performance of furnaces and generators manufactured by Surface Combustion Corp., Toledo 1, Ohio.

Surface
STEEL MILL FURNACES

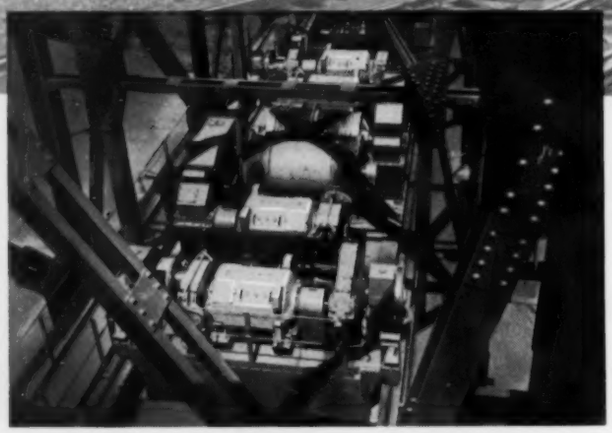


Foreign associates:
British Furnaces, Ltd., Chesterfield; Stein & Atkinson, Ltd., London
Stein & Roubaix, Paris, Leige, and Genoa; Chugai Ro Kogyo Kaisha, Ltd., Osaka
Benno Schilde Maschinenbau, A.G., Bad Hersfeld (Hessen, Germany)

New ore bridges for U.S. Steel's



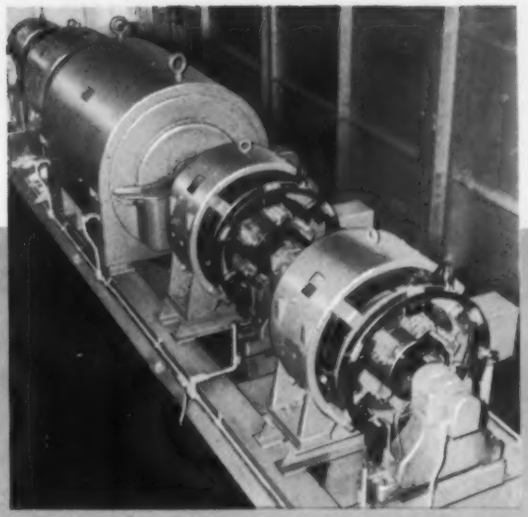
The two Heyl & Patterson 22½-ton ore bridges at United States Steel Corporation's Ohio works. Drawing at left shows the essential parts of the installation. The motor-generator set, installed on one of the bridge legs, provides the adjustable voltage d-c which operates the hoist, trolley, and bridge drive motors.



Two 250-hp hoist engine drive motors hoist, open and close the bucket. Outboard of these motors are two identical Elliott motors which drive the trolley along its rails.

Each truck has two gravity-set rail clamps, like the one shown here, to augment the motor brakes in immobilizing the giant 1300-ton structure on its track. A 6½-hp Elliott mill type motor releases clamp.

Ohio Works...



Elliott motor-generator set which converts incoming 2300-volt, 25-cycle power supply to adjustable voltage d-c. Two 250-kw generators in foreground supply bucket hoist and bridge travel motors. Larger 400-kw generator, in rear, supplies power for motors which drive the trolley.

When increased blast furnace capacity required the installation of two new ore bridges at the United States Steel Corporation's Ohio Works, Youngstown, Ohio, designers incorporated all the most modern innovations and features. By using adjustable voltage electrical control, bridge motions are controlled more precisely and smoothly. Speed control is improved and hoisting speed is increased. In addition, greater bridge capacity is obtained without increase in the size or number of motors by operating the motors at near double-rated voltage and double speed. As the original power supply is a-c, no increase in d-c capacity of the plant is necessary. Other important advantages are less maintenance and less over-all power consumption.

BY ELLIOTT

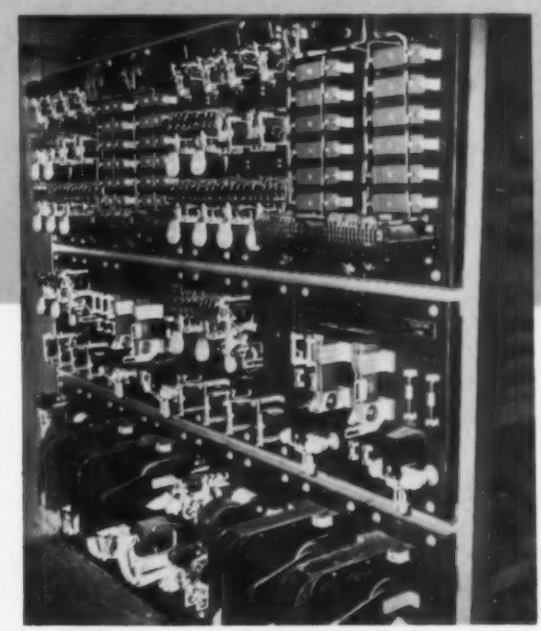
All major electrical equipment, including controls, was furnished by Elliott Company. Both Elliott engineers and Elliott equipment are thoroughly at home in steel mill operations. Take advantage of this experience. Consult your local Elliott field engineer or write Elliott Company, Crocker-Wheeler Division, Jeannette, Pa. for full information.

ELLIOTT Company

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

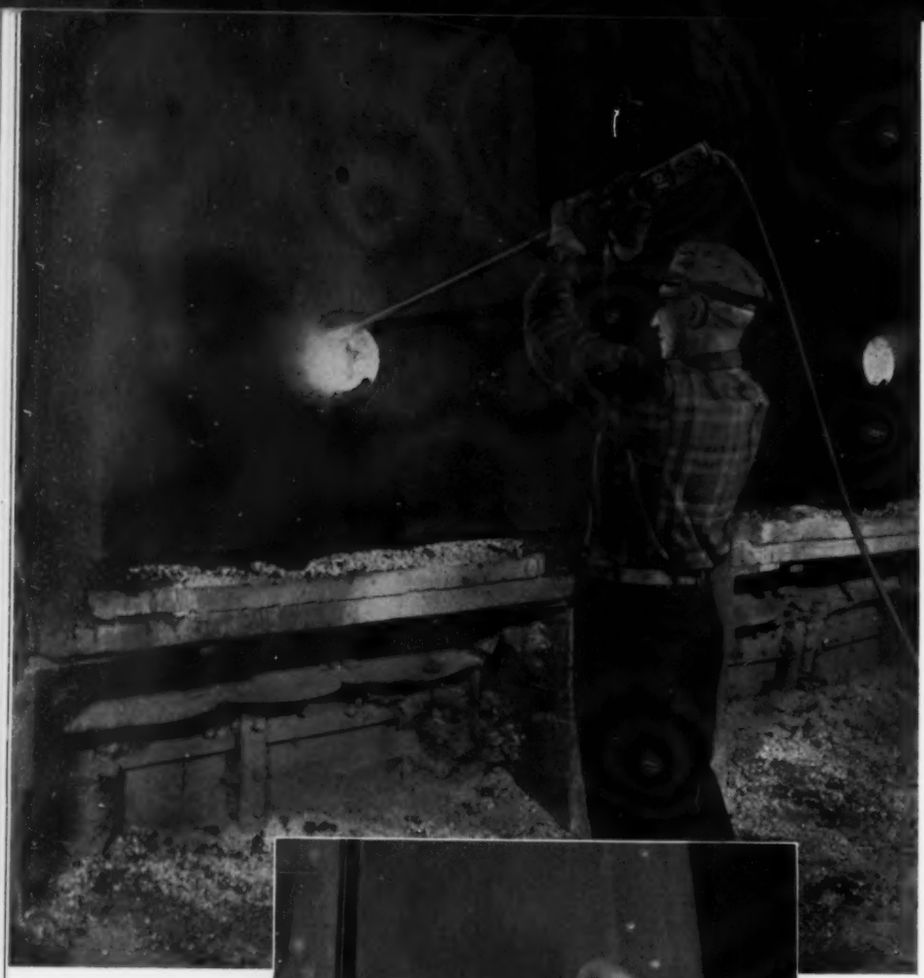
Control for the generators, located in the enclosed, pressurized motor-generator house.

One of the pairs of two-rail trucks which support the pier leg of the bridge. A 100-hp Elliott mill type motor, equipped with brake, drives each truck.



Part of the adjustable voltage control equipment furnished by Elliott for each bridge. This is a portion of the motor control installed in the trolley cab.

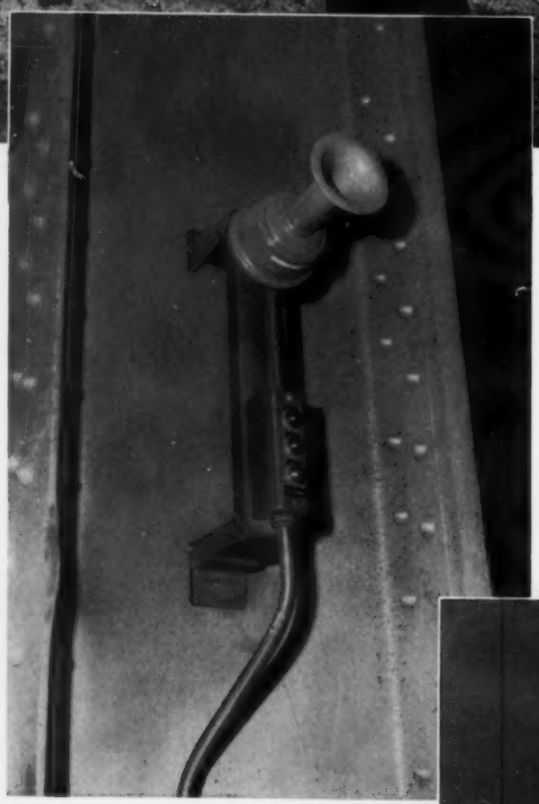
WB-11



The

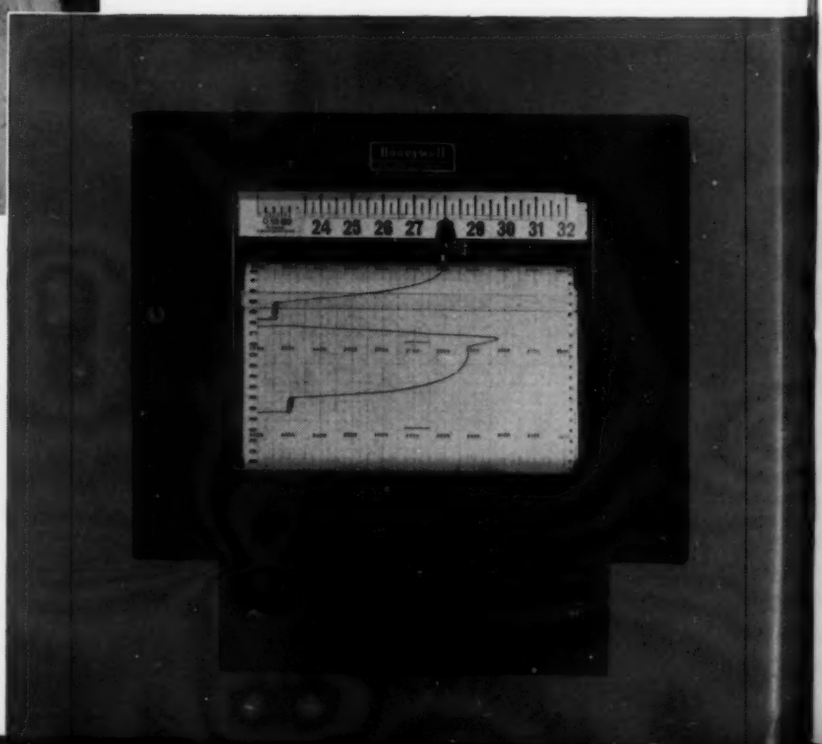
1

Insert the Brown thermocouple *through the wicket hole and into the bath. The assembly weighs less than 40 pounds . . . is easily handled by one man.*



2

Watch the signal lights. *Mounted near the furnaces, they tell the operator when the couple is correctly connected, instrument is standardized, couple is preheated, and measurement is completed. There's no need to have a second man stationed at the instrument.*



3

A complete, accurate record *of the measurement is drawn on the* ***ElectroniK*** *instrument, which can be located hundreds of feet from the furnace. The recorder standardizes itself the instant a thermocouple is connected . . . stays always ready to deliver top accuracy.*

accurate, simple economical way to measure molten steel bath temperature

MEASUREMENTS of molten steel bath temperatures in open hearth and electric furnaces reach a new high in simplicity and precision . . . and a new low in cost . . . with *ElectroniK* instrumentation. The automatic signalling system eliminates the guesswork of arbitrarily set immersion time. It tells the operator the instant that the measurement is completed . . . enables him to withdraw the couple immediately and thus prolong its useful life, without detracting from accuracy of measurement.

The system ends all doubt about thermocouple condition. If the first signal—a green light—fails to light, the operator knows that the thermocouple is open. One company estimates that the system has paid for itself by preventing the expense of contaminated couples.

One man can perform the entire measurement. He doesn't need to consult the recorder, which can be mounted at any desired distance from the furnace. You save on thermocouples, on production . . . even on chart paper, for the chart moves only when a measurement is being made. And you get the high order of precision in bath temperature readings that enables you to eliminate hot or cold heats, to reduce skulls and stool stickers, and improve ladle and mold life.

Your local Honeywell sales engineer will be glad to discuss how you can profitably utilize the *ElectroniK* system in your own shop. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA: Write for Data Sheet No. 6.4-8b, "Molten Steel Temperature Measurements."**

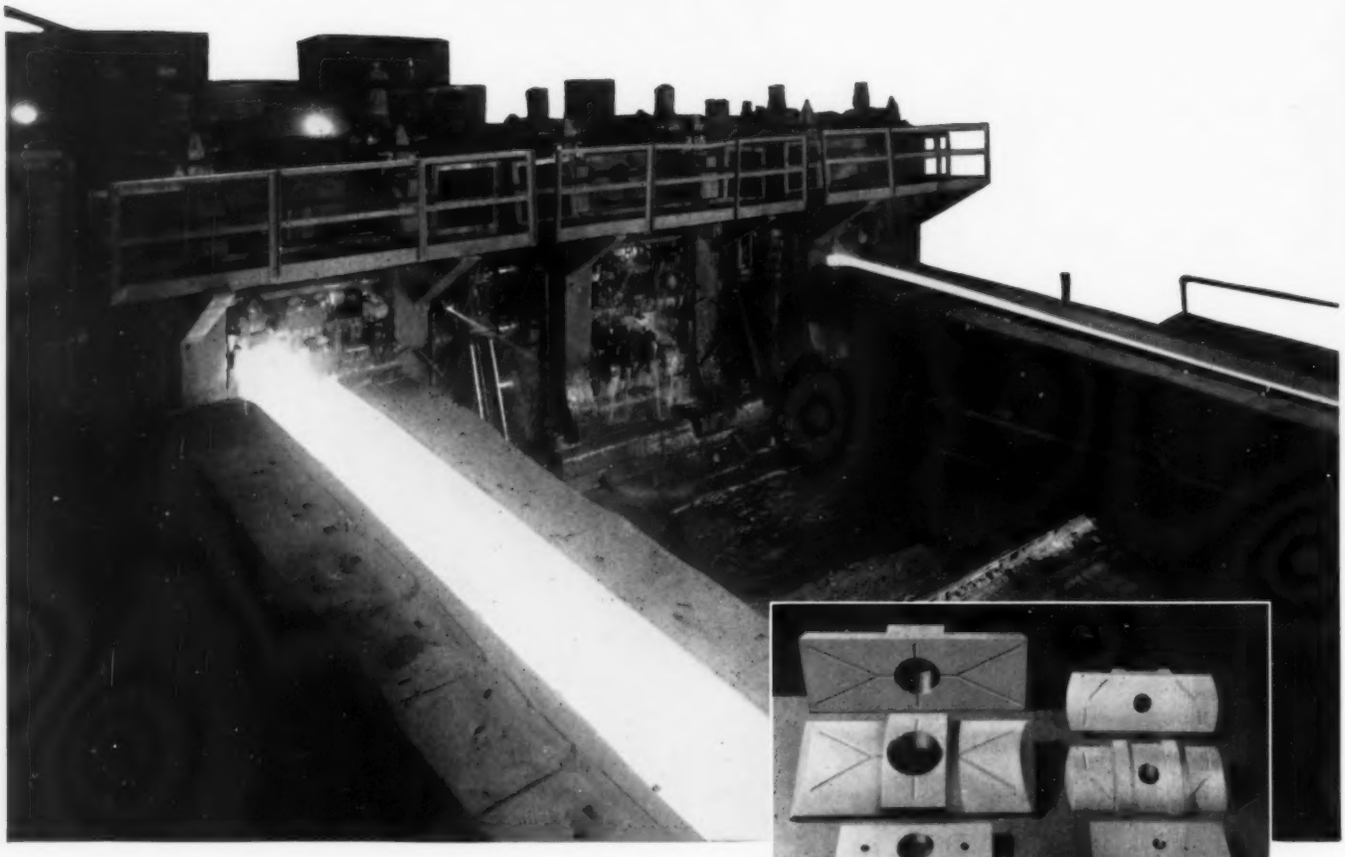
H HONEYWELL

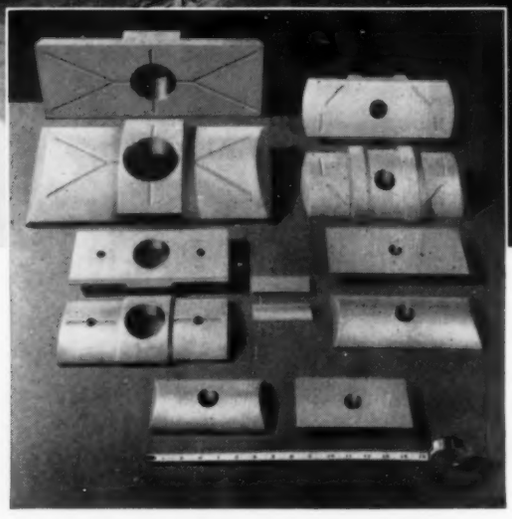
MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

Production Steps Up Costs Step Down





. . . when you use AMPCO* SLIPPERS

THERE'S plenty of "plus value" in slippers cast of Ampco Metal. They're tough — have unusual resistance to wear. They withstand the tremendous impacts and shock loads of steel-mill operation without squashing out. They have high fatigue strength.

These properties mean lower costs for you — less downtime — longer runs without replacement.

You get these slippers in the form you need to meet your specific operation. They're available "cast-to-size" or as rough castings. "Cast-to-size Slippers" come either with tolerances of minus 0, plus 1/32; or plus 0, minus 1/32. Oil grooves are cast in, if you want them.

And that's not all. Ampco Metal's stamina, toughness, and corrosion resistance mean that it's ideally suited for cutting costs in other steel-mill applications, too — screw-down nuts, wear plates, flash-welder dies, pickling equipment. Get the whole money-saving story from your nearby Ampco field engineer or write us direct

G-20

*Reg. U. S. Pat. Off.

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West of the Rockies it's Ampco's Burbank Plant, Burbank, California

The Results of this Important Research Project are basic to every man who faces a Rust Problem

RUST-OLEUM®
A CORPORATION
STOPS RUST!

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EVANSTON • ILLINOIS

IN REPLY PLEASE REFER TO FILE NO. 1

September 15, 1955

SUBJECT: Special Report to Industry

It is generally recognized by engineers and corrosion experts that there is far more to stopping rust on a rusted surface, than just applying any type of material at a certain film thickness. Dry film thickness of a protective coating is important--but, it's what goes on UNDER the film surface that counts, too. The vehicle of the coating that's applied over rust must penetrate to bare metal, driving out the air and moisture that, in presence of metal, cause rust.

Rust-Oleum users, for over thirty years, have known that Rust-Oleum does exactly that through practical use and results of the application of the product. However, Rust-Oleum wanted to go even further in bringing you irrefutable proof of this penetration.

With this in mind, the Rust-Oleum Corporation consulted with technologists from the Battelle Memorial Institute in Columbus, Ohio, who conducted this important research project, utilizing radioactive tracing technique with C^{14} radioisotope to measure Rust-Oleum penetration. Now, after nearly three years of continued research, you can actually look UNDER the surface film and see how the Rust-Oleum penetration, after nearly penetrates rust to bare metal.

The methods and results of this research, which are outlined on the following pages, are given in their entirety in a thirty-page report entitled, "The Development of a Method to Determine The Degree of Penetration of a Rust-Oleum Fish-Oil-Based Coating Into Rust Coatings on Steel Specimens," prepared by Battelle Memorial Institute technologists. It is available to you without cost or obligation by request on your business letterhead.

Very truly yours,

RUST-OLEUM

Robert A

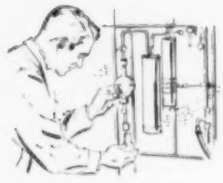
President

RAF/jc

Now! For the first time, actually look *under* the surface of the coating! See Rust-Oleum *penetrate rust* to bare metal through the "eyes" of radioactivity!

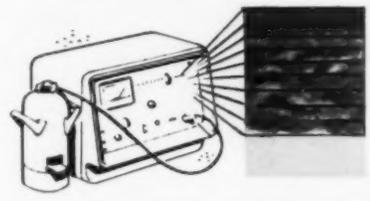
(A RUST-OLEUM REPORT TO EVERY PERSON FACED WITH A RUST PROBLEM)

Nearly three years of research, utilizing radioactive tracing with C^{14} radioisotope, enables you to follow Rust-Oleum penetration through the heretofore "unseen" rust area to bare metal. While Rust-Oleum users, for over thirty years, have known that Rust-Oleum penetrates rust to bare metal when applied over rusted surfaces—Rust-Oleum wanted to go even further in bringing irrefutable evidence of this penetration to you. The methods and results, on which the technical information on these pages is largely based, are presented in a complete thirty page report entitled, "The Development of a Method to Determine The Degree of Penetration of a Rust-Oleum Fish-Oil-Based Coating Into Rust Coatings on Steel Specimens," prepared by Battelle Memorial Institute technologists. Request your copy on your business letterhead without cost or obligation.



1 To trace Rust-Oleum penetration through rust, the Rust-Oleum fish oil vehicle was made radioactive with C^{14} radioisotope. The radioactive Rust-Oleum fish oil vehicle was then formulated into Rust-Oleum 769 Damp-Proof Red Primer without changing Rust-Oleum's exclusive formulation or performance of product.

2 Rusted metal test panels were scraped and wirebrushed to remove rust scale and loose rust, according to Rust-Oleum's standard directions for application. The radioactive Rust-Oleum 769 Damp-Proof Red Primer was then brushed on directly over the remaining rust on these rusted test panels and allowed to dry.



3 Then—the surfaces of the rusted panels were shaved at approximate half-mil levels and Geiger Counter readings of Rust-Oleum penetration (radioactivity) were taken at each level down to bare metal. These measurements are shown as "Percentage of Surface Radioactivity" figures on the graph on the opposite page.

Dry film thickness of a coating is important, but, what goes on UNDER the film surface is vitally important, too, in the stopping of rust. Rust-Oleum Stops Rust, because it penetrates the rust to bare metal. The Rust-Oleum fish oil vehicle works around the rust particles and through the fissures and crevices in the rust formation to the bare metal. It doesn't "bridge-over" the tiny, microscopic pits in the metal—BUT, actually goes into these pits to drive out air and moisture and coat the metal with a penetrating, low-surface-tension film that expands and contracts with the metal. Because of this unusual penetration, you can apply Rust-Oleum 769 Damp-Proof Red Primer directly over the rusted surface after scraping and wirebrushing to remove rust scale and loose rust. Thus—you save time, labor, and money as costly surface preparations are usually eliminated.

From tanks, girders, machinery, roofs, sash, stacks, pipes, wire fences, and building maintenance in industry . . . marine, farm, or railroad applications . . . to gutters, metal sash, lawn furniture, etc. around the home . . . Rust-Oleum is the modern way to Stop Rust and beautify as you protect, in your choice of Red, White, Black, Aluminum, Gray, Green, Yellow, Blue, etc. May be applied by brush or spray and dries to a firm, *decorative* coating that resists salt water, salt air, heat, fumes, sun, humidity, and weathering. Industrial users see Sweets for complete catalog and nearest Rust-Oleum Distributor, or attach coupon on the opposite page to your business letterhead for complete information, including your thirty-page report on Rust-Oleum penetration. Homeowners will find Rust-Oleum featured at leading Hardware, Paint, and Lumber dealers in most localities.

there is only one Rust-Oleum . . . *it is distinctive as your own fingerprint*

RUST-OLEUM®

Rust-Oleum is exclusive. It incorporates a specially-processed fish oil vehicle that penetrates through rust to bare metal. It dries right and is free of objectionable odor. Many attractive colors.

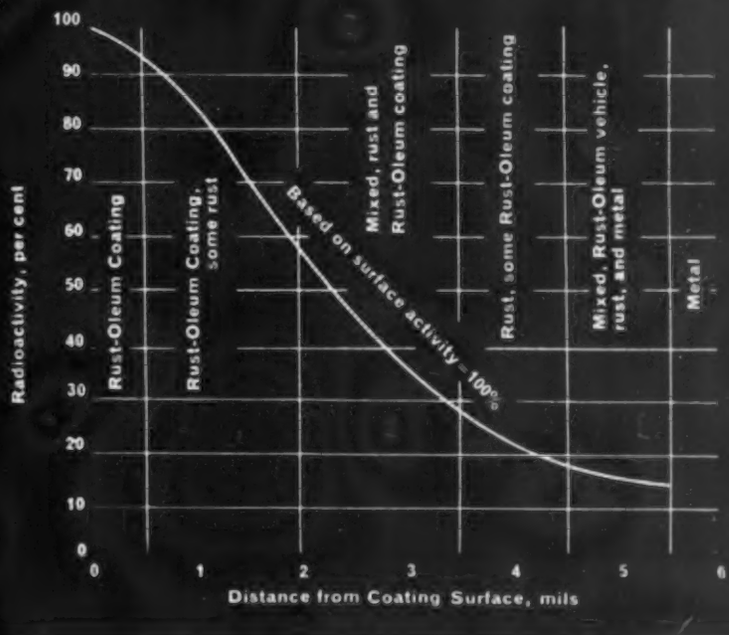
STOPS RUST!

A new Rust-Oleum development is the Rust-Oleum Galvinoleum coating. It sticks to new or old galvanized surfaces *without* etching, *without* weathering. Available in red, gray, green, metallic.

Photomicrograph (enlarged 250 times) of cross-section of rusted metal coated with Rust-Oleum.

Actual unretouched photomicrograph (enlarged 250 times) showing cross-section of rusted metal coated with Rust-Oleum. Geiger Counter readings were taken at each half-mil level down through the rust — tracing Rust-Oleum penetration through rust to bare metal.

Graph (at right) shows Geiger Counter recordings of Rust-Oleum penetration. Visible evidence of Rust-Oleum penetration as recorded by Geiger Counter and Gas Flow Proportional Counter is shown on graph. Rust-Oleum penetration is expressed in terms of "Percentage of Surface Radioactivity" figures at given mil levels. Note how Rust-Oleum pigment and fish oil vehicle combined penetrate to approximately four mils—then the fish oil vehicle penetrates through remaining rust to bare metal.



GET THE COMPLETE STORY. ATTACH TO YOUR BUSINESS LETTERHEAD FOR YOUR COPY OF THIS THIRTY-PAGE REPORT WITHOUT COST OR OBLIGATION.

Rust-Oleum Corporation
2980 Oakton Street, Evanston, Illinois

- ☐ Please send me without cost or obligation, the Rust-Oleum thirty-page report entitled, "The Development of a Method To Determine The Degree of Penetration of a Rust-Oleum Fish-Oil-Based Coating Into Rust Coatings On Steel Specimens," as prepared by Battelle Memorial Institute technologists.
- ☐ Complete literature and color charts.
- ☐ Nearest source of supply.

...there is only one Rust-Oleum...it is distinctive as your own fingerprint

RUST-OLEUM IS EXCLUSIVE. Most manufacturers of protective materials specify that rusted metal surfaces must be free of rust before applying their product. Rust-Oleum does NOT! With Rust-Oleum you simply scrape and wirebrush to remove rust scale and loose rust —then brush Rust-Oleum 769 Damp-Proof Red Primer directly over the remaining rust. The specially-processed fish oil vehicle penetrates rust to bare metal, merging the rust particles into the coating. It dries to a firm, decorative coating that resists salt water, salt air, heat, fumes, humidity, sun, moisture, and weathering. This unusual penetration saves you time, labor, money, and metal because sandblasting, chemical pre-cleaning, and other costly surface preparations are usually eliminated.

AVAILABLE IN *MANY COLORS.* You beautify as you protect because Rust-Oleum is available in many, many attractive colors including Aluminum, White, Black, Green, Red, Gray, Orange, Yellow, Blue, etc. In addition to industrial rust preventive coatings, Rust-Oleum finish coatings, incorporating the same specially-processed fish oil vehicle, are available (1) to match original equipment manufacturer's colors for farm and road and highway construction equipment, (2) Oil Field finishes to match original equipment colors for rigs, pumps, etc., (3) Restful Colors for plant and institutional interiors, (4) Special Marine and Railroad finishes, (5) Heat Resistant and Chemical Resistant finishes, (6) Masonry and Floor Coatings.

RUST-OLEUM®

Remember—Rust-Oleum's unusual rust-resistant qualities enable you to apply Rust-Oleum 769 Damp-Proof Red Primer one season—and wait until the following season to use your Rust-Oleum finish coating. Thus—you "stretch" maintenance budgets season-to-season.

STOPS RUST!

Write on your business letterhead for your copy of the special Rust-Oleum thirty-page report, entitled, "The Development of a Method to Determine The Degree of Penetration of a Rust-Oleum Fish-Oil-Based Coating Into Rust Coatings on Steel Specimens." We'll be glad to send it to you promptly, and there is no cost or obligation.

Rust-Oleum Corporation • 2980 Oakton Street • Evanston, Illinois

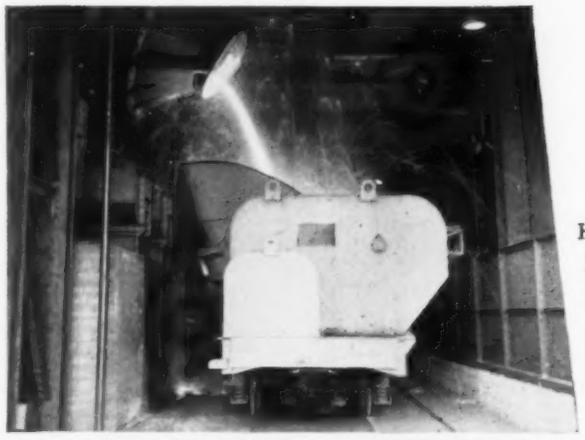
EC&M Control is Safe for Hot Metal Applications

Bessemer Converters operate *safely* under EC&M Control. This three-converter installation is typical of many EC&M controlled converters.

Wherever hot metal is stored, handled, or processed, many firms, acquainted with EC&M value, select this quality apparatus because of their confidence in it—in the engineering and experience which it represents.

Typical hot metal applications include (1) Ladle Cranes, (2) Hot Metal Cranes, (3) Hot Metal Mixers, (4) Bessemer Converters, (5) Storage Vessels, (6) Ladle Cars—where only tried and true equipment, which represents the utmost in safety and dependability, is acceptable.

Listed below are a few of the EC&M products especially designed for the requirements of hot metal service. They have proved themselves highly successful in many applications throughout the years. Specify EC&M Control for hot metal applications.

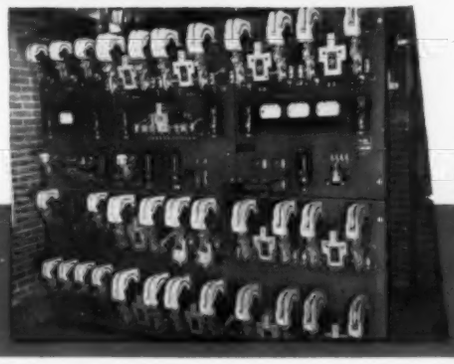


Hot metal mixer pouring into hot metal car, both of which are operated by EC&M Control.

EC&M power-circuit type Limit Stops mounted on hot metal mixer (shown above), provide positive slowdown and final stopping.

EC&M EQUIPMENT
Especially Designed for Hot Metal Service

1. Basic Control Systems for Bessemers & Mixers, many originated by EC&M.
2. Dead - Man's Master Switch.
3. Air and Magnetically-released Brakes.
4. Positive-type Limit Stops for Slowdown and Final Stopping.
5. LINE-ARC Magnetic Contactor Controllers.



LINE-ARC Contactor Control for the hot metal car propel-motion.

THE ELECTRIC CONTROLLER & MFG. CO.
4498 LEE ROAD • CLEVELAND 28, OHIO

Announcing **New, 30 and 60 Amp.**

Arktite

HEAVY DUTY

PLUGS & RECEPTACLES

NEW pressure connectors; no soldering unless you prefer to do it.

NEW easier-to-wire interior assembly; comes out in one piece—just remove 2 screws.

NEW easier-to-interchange plug and receptacle interiors; no machining; no special tools.

NEW plug adaptability; takes any size portable cable up to full 30 or 60 amp. capacity.

Circuit-Breaking Features Make Arktite Safe at Full Load Without Disconnect Switches

Each contact is insulated in a separate chamber. Arcs formed while making or breaking circuit are snuffed out in arcing chambers by pressure-deionization and lack of oxygen. No chance of flash-over even if break is made at full load. With grounding contacts longer than load contacts, plug and tool are grounded *before* circuit is made and *after* it is broken.

New *Arktites* now available in 30 and 60 amp. sizes — 2-pole, 3-pole and 4-pole styles. Fully interchangeable with old *Arktites* — *same economical price.*

SEND FOR FREE BULLETIN

OR SEE YOUR CROUSE-HINDS DISTRIBUTOR.

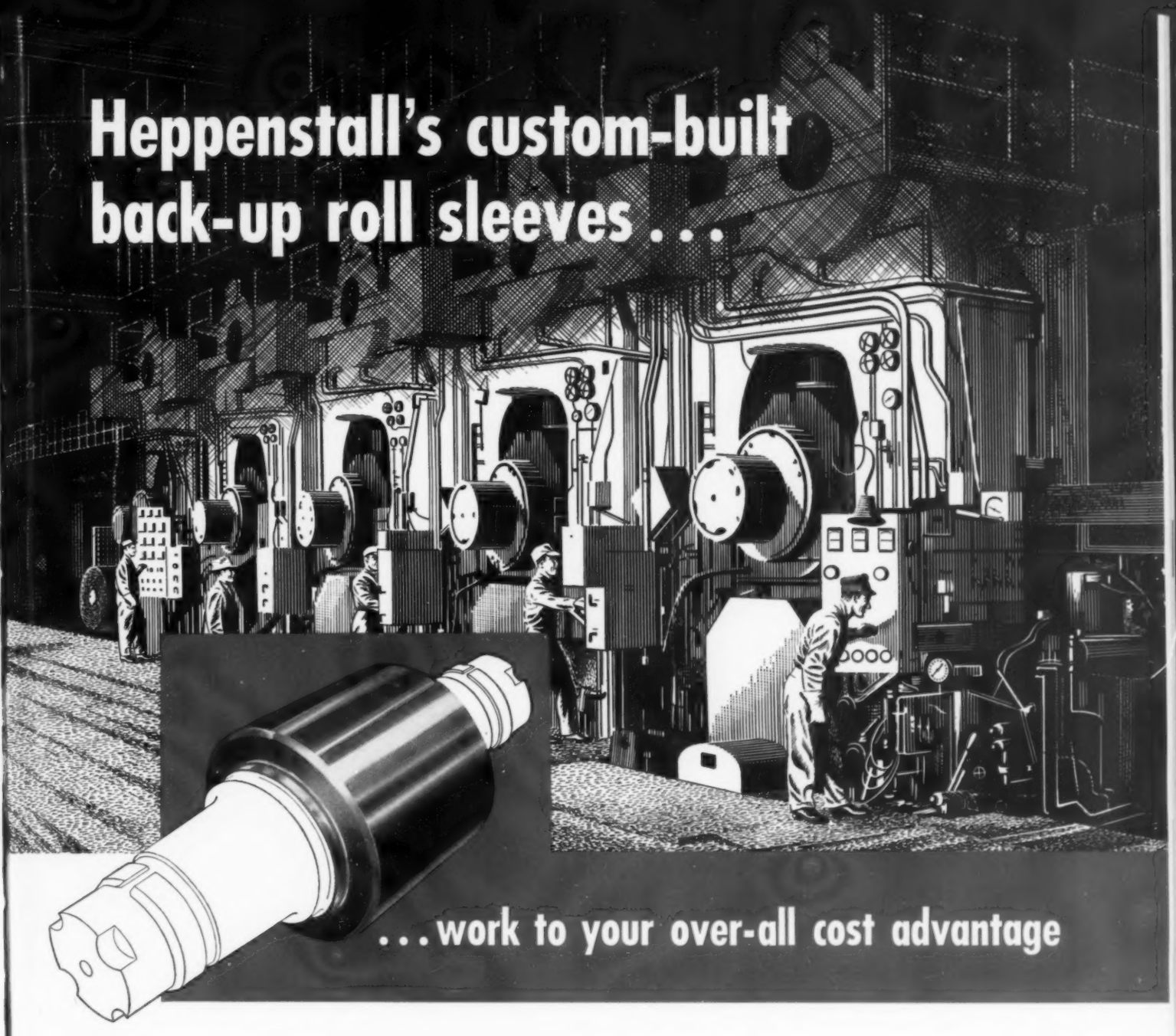
A NATIONWIDE DISTRIBUTION exclusively through ELECTRICAL DISTRIBUTORS

CROUSE-HINDS COMPANY

SYRACUSE 1, N.Y.

CONDULETS • FLOODLIGHTS • TRAFFIC SIGNALS • AIRPORT LIGHTING

Heppenstall's custom-built back-up roll sleeves . . .



. . . work to your over-all cost advantage

Heppenstall Back-Up Roll Sleeves enable you to roll record tonnages . . . decrease downtime . . . and effect over-all cost reduction. They give longer working life in today's high-speed mills because their up-to-the-minute design permits utilization of more effective forging and heat treating operations in their production. Each sleeve's working surface is *tempered to meet your exact hardness specification.*

These mandrel-forged sleeves—made from highest quality Heppenstall-produced alloy steel—are worked thoroughly under modern hydraulic presses to produce a finished product having both maximum density and grain refinement. In addition, they offer you exactness of fit and greater resistance to cracking and spalling during high-speed rolling.

All Heppenstall sleeves are fitted to extremely close tolerances which prevent circumferential slippage. Longitudinal movement is also eliminated because they are further locked in place by both a shoulder and Heppenstall's own patented locking ring.

Heppenstall also produces forged arbors . . . has facilities to grind both arbors and sleeves for perfect shrink-fitting.

For additional information and technical assistance, contact Heppenstall Co., Pittsburgh 1, Pennsylvania. Sales offices are located in principal cities.

Heppenstall

The most dependable name in forgings

KLOZURE* OIL SEALS

USED EXCLUSIVELY on RBC's new Sealed "Pitchlign" Roller Bearings

Springless KLOZURE Oil Seal Model 71-A, with synthetic rubber sealing member securely bonded to and integral with a metal case.

In designing their new sealed "Pitchlign" roller bearing, the Roller Bearing Company of America (W. Trenton, N. J.) needed a proven, dependable oil seal of narrow cross section.

RBC engineers selected springless KLOZURE Model 71-A. They found this superior seal was specifically designed for limited space applications. In addition, Model 71-A had proved on thousands of applications that it would keep out dust and retain the lubricant for the *life of the bearing.*

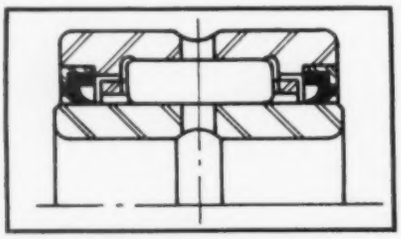
Let us show you how Garlock KLOZURES can solve your sealing problems. There's a proven KLOZURE model for every bearing application.

For full information contact the Garlock office nearest you or write for KLOZURE Catalog No. 10.

*Registered Trademark

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

Sales Offices and Warehouses: Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, Los Angeles, New Orleans, New York City, Palmyra (N. Y.), Philadelphia, Pittsburgh, Portland (Oregon), Salt Lake City, San Francisco, St. Louis, Seattle, Spokane, Tulsa.
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.



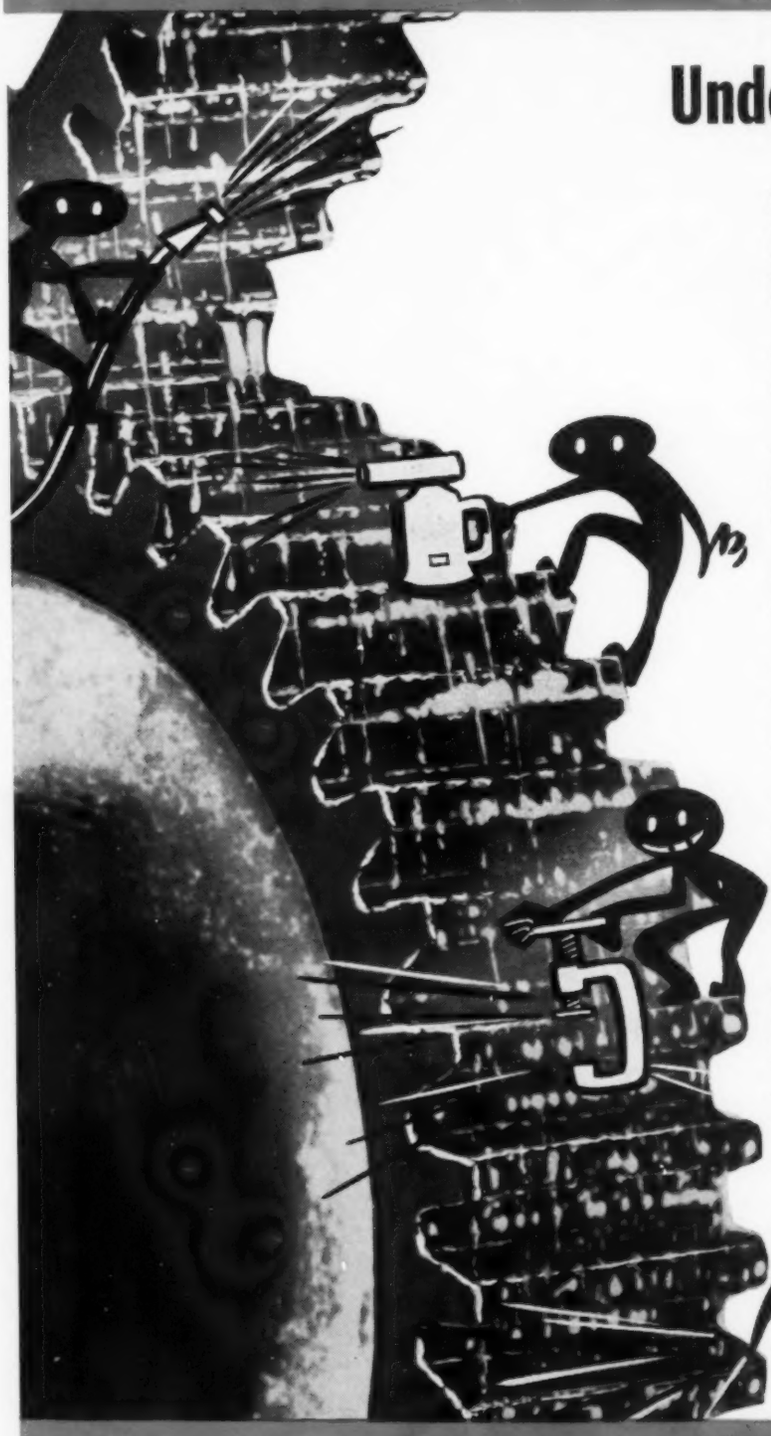
Two springless KLOZURES, lips turned in, on "Pitchlign" bearing provide life-time retention of the lubricant.

RBC's new sealed "Pitchlign" roller bearing with two built-in springless KLOZURES.

GARLOCK

PACKINGS, GASKETS, OIL SEALS
MECHANICAL SEALS
RUBBER EXPANSION JOINTS

Houghton TENAC Adheres to gears longer



Under TOUGH Conditions!

Stand-Out Advantages of this Free-Flowing, Fast-Setting Lubricant Make it Ideal For Your Heaviest Gear and Cable Applications . . .

- **EASY APPLICATION**—Use brush, swab, spray or drip feed—no preheating necessary.
- **FAST SETTING ACTION**—Tenac contains a special solvent which evaporates after application, leaving a tough, elastic film.
- **HIGH FILM STRENGTH**—Tenac's tough, flexible film will not separate or become brittle.
- **LONG-LASTING PROTECTION**—Tenac continues to protect metal surfaces even after extended periods of heavy duty service.
- **HIGH FLASH POINT**—Flash point for Tenac is far higher than that of similar lubricants.
- **PRE-TESTED**—Passes "Four Gram Retention Test".

For more detailed information on how Tenac, available in 3 grades — can reduce your lubricant costs, call your Houghton Man or write to E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Pa.

• FOR ALL OPEN GEARS AND CABLES— Tenac Lubricants (Light, Medium and Heavy) are recommended for open gears and cables of presses, shovels, hoists, elevators, shears, overhead cranes, open drives, etc.

TENAC—A PRODUCT OF

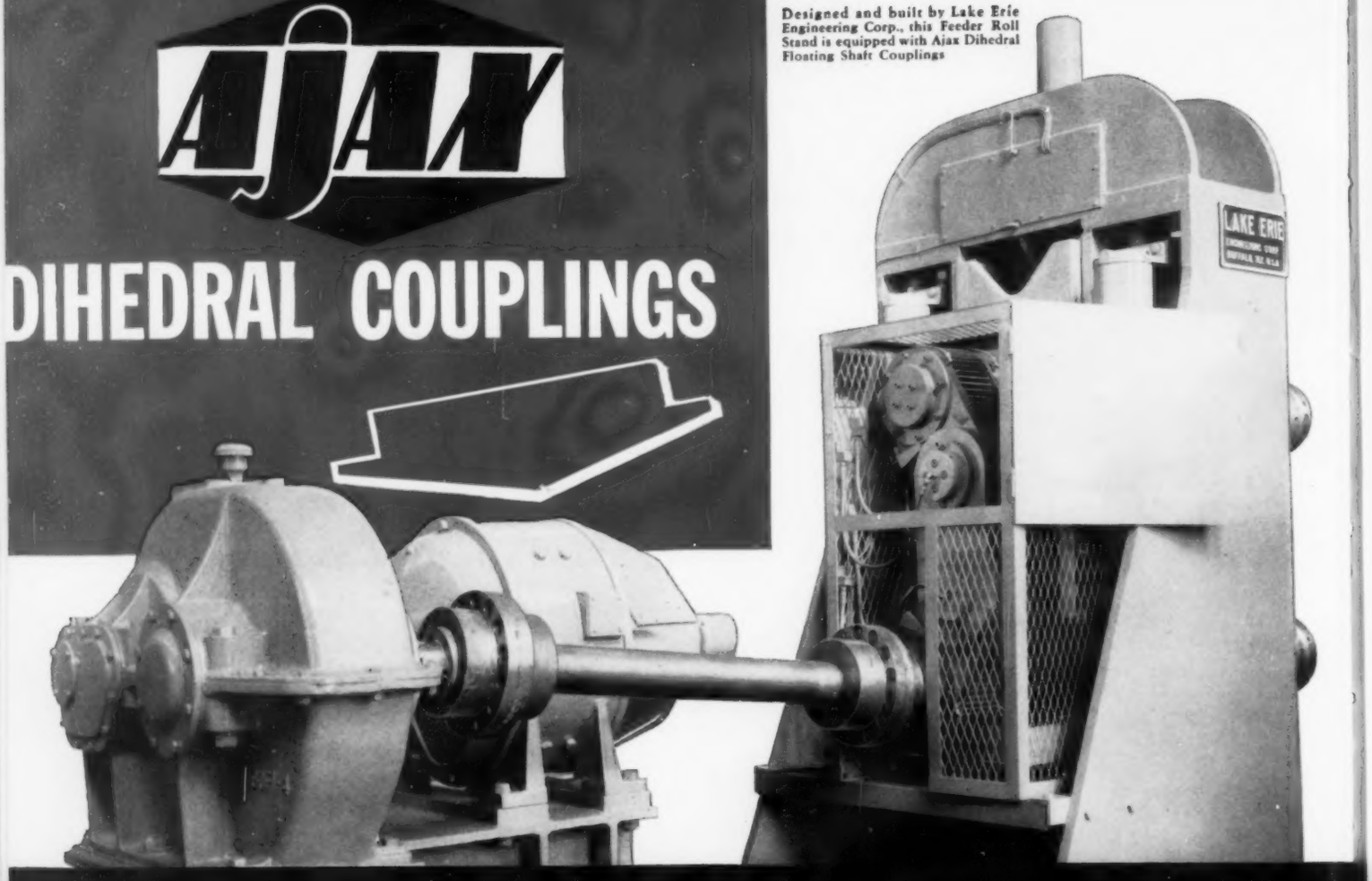
E F HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

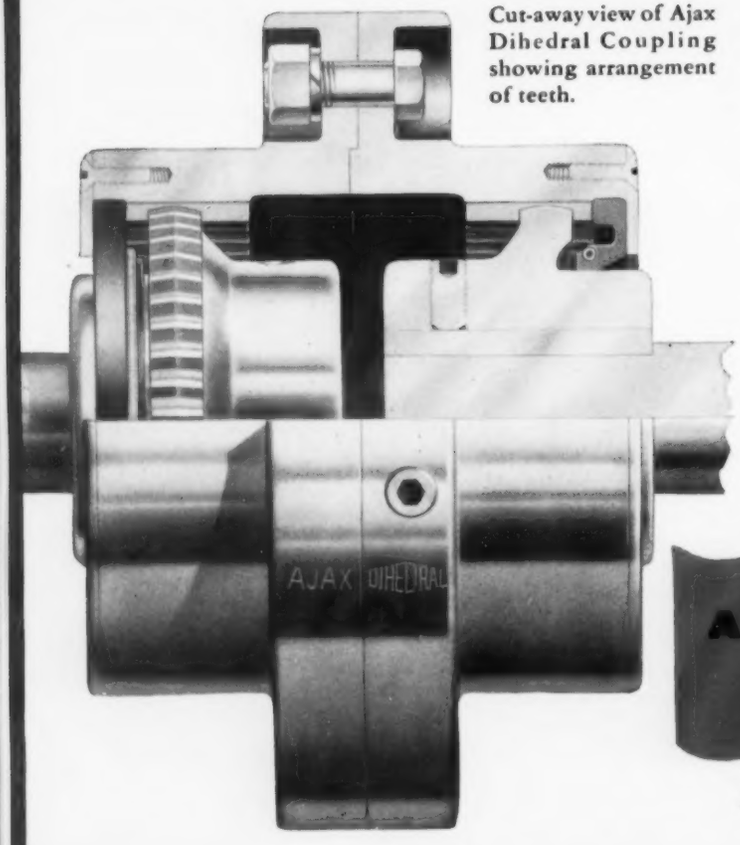
AJAX

DIHEDRAL COUPLINGS



Designed and built by Lake Erie Engineering Corp., this Feeder Roll Stand is equipped with Ajax Dihedral Floating Shaft Couplings

Ending Alignment Problems of Direct-Connected Machinery



Cut-away view of Ajax Dihedral Coupling showing arrangement of teeth.

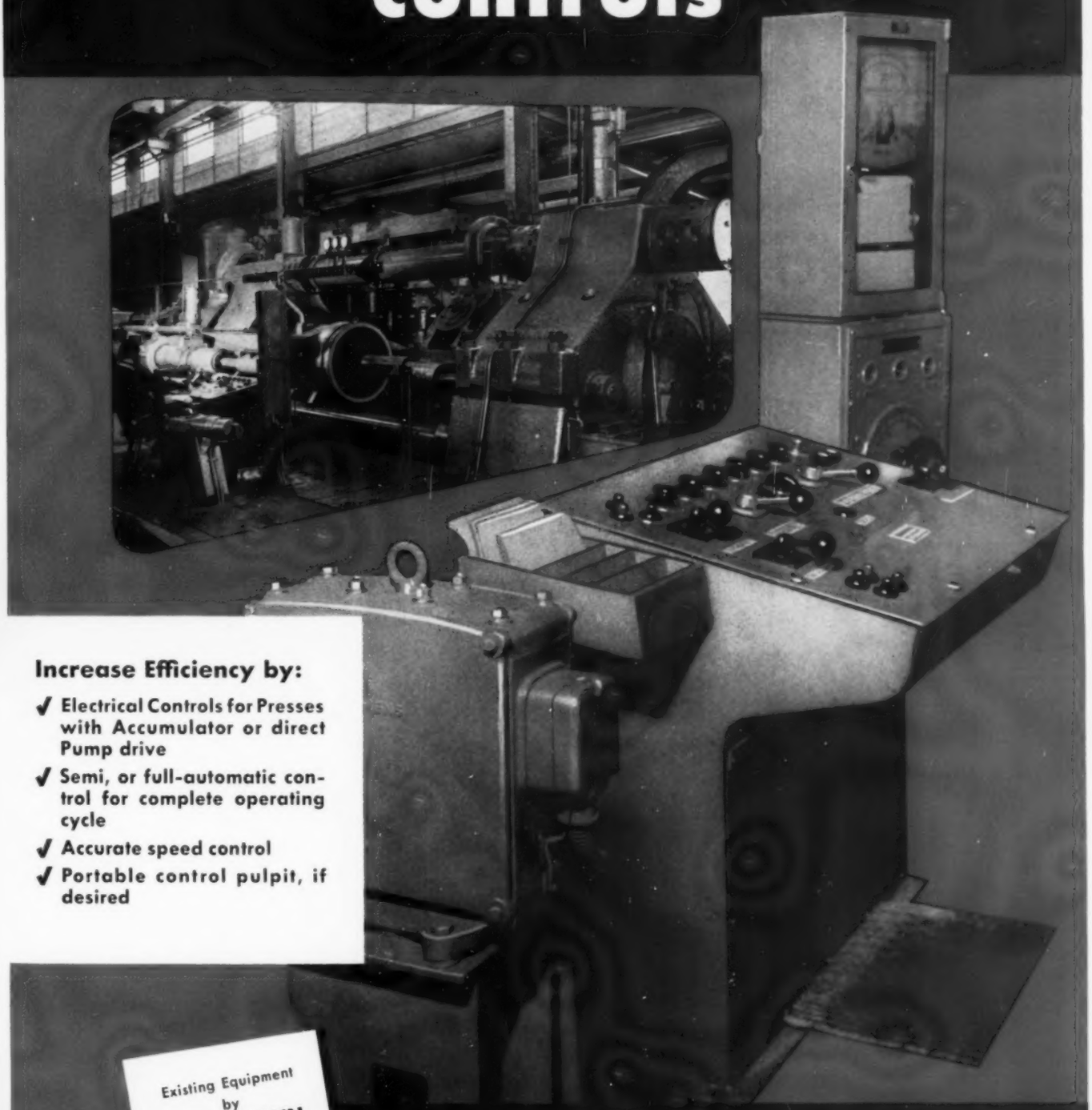
● Ajax Dihedral Self-aligning Couplings handle misalignment heretofore impossible with conventional couplings. Their ability to handle angular, offset and end float misalignment up to a total of 12 degrees is based on Ajax patented dihedral tooth design.

Get the facts on how manufacturers of presses, machine tools, rolling mills, cranes, earth moving and many other direct-connected machines are simplifying design, cutting manufacturing costs and improving performance with Ajax Dihedral Couplings. Write for Bulletin 52.

AJAX FLEXIBLE COUPLING CO. IN
WESTFIELD, N. Y.

Also Manufacturers of Ajax Rubber-Bronze Bushed Couplings, and Ajax Vibrating Screens and Conveyors.

SCHLOEMANN controls



Increase Efficiency by:

- ✓ Electrical Controls for Presses with Accumulator or direct Pump drive
- ✓ Semi, or full-automatic control for complete operating cycle
- ✓ Accurate speed control
- ✓ Portable control pulpit, if desired

Existing Equipment by **SCHLOEMANN**

Domestic users of equipment built by Schloemann are assured of competent service-engineering, supply of genuine spare and repair parts. Call a Feller service engineer.

FELLER ENGINEERING COMPANY

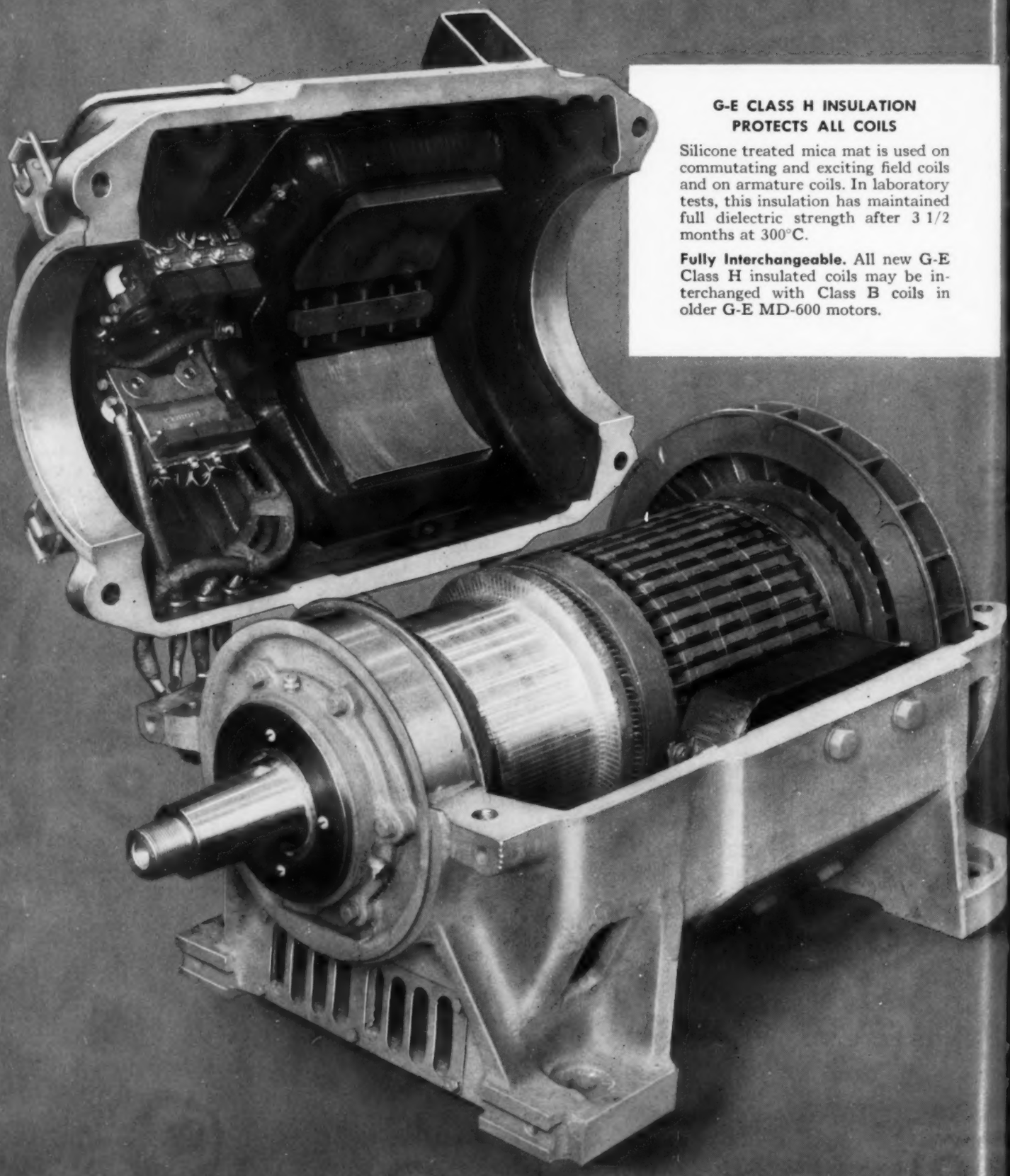
1161 Empire Bldg., Pittsburgh 22, Pa.

Exclusive U.S. Agent

PROGRESS IN
DIRECT-CURRENT DRIVES

NOW! Roastouts

NEW G-E MD-600 MOTORS



G-E CLASS H INSULATION PROTECTS ALL COILS

Silicone treated mica mat is used on commutating and exciting field coils and on armature coils. In laboratory tests, this insulation has maintained full dielectric strength after 3 1/2 months at 300°C.

Fully Interchangeable. All new G-E Class H insulated coils may be interchanged with Class B coils in older G-E MD-600 motors.

Virtually Eliminated on . . .

WITH CLASS H INSULATION

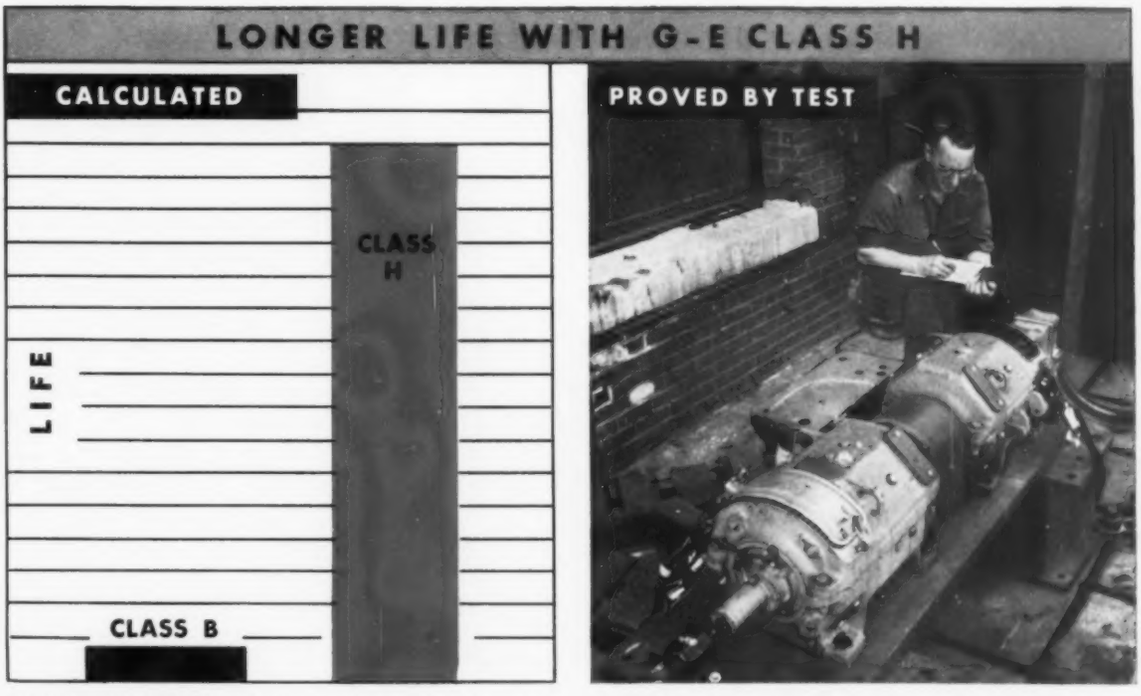
G.E. offers—in all MD-600's—Class H Insulated Coils

WHAT IS CLASS H? General Electric research has developed a combination of inorganic and silicone materials for a new insulation system now used in all MD-600 motors. These Class H materials will withstand temperatures up to 180°C continuously.

BETTER FOR HEAVY DUTY. Auxiliary mill motors often encounter unexpected high ambient temperatures, unforeseen extended duty or emergency conditions. Any one of these can cause "roastouts" from temperatures higher than the insulation capacity. The new G-E Class H insulation will resist up to 50°C more than Class B, resulting in longer motor service.

REWINDS ELIMINATED? On normal duty, insulation failure may be eliminated as the limiting factor in continuous armored motor service. Engineers calculate that each 10°C rise in temperature reduces the life of a given type of insulation by half. *Since G-E Class H will withstand 50°C higher than Class B, its life* **at the same temperature** *should be increased 2^5 or 32 times!*

YOUR G-E SALES REPRESENTATIVE HAS COMPLETE INFORMATION. Contact him at your nearby G-E Apparatus Sales Office, or write Section 812-1, Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.

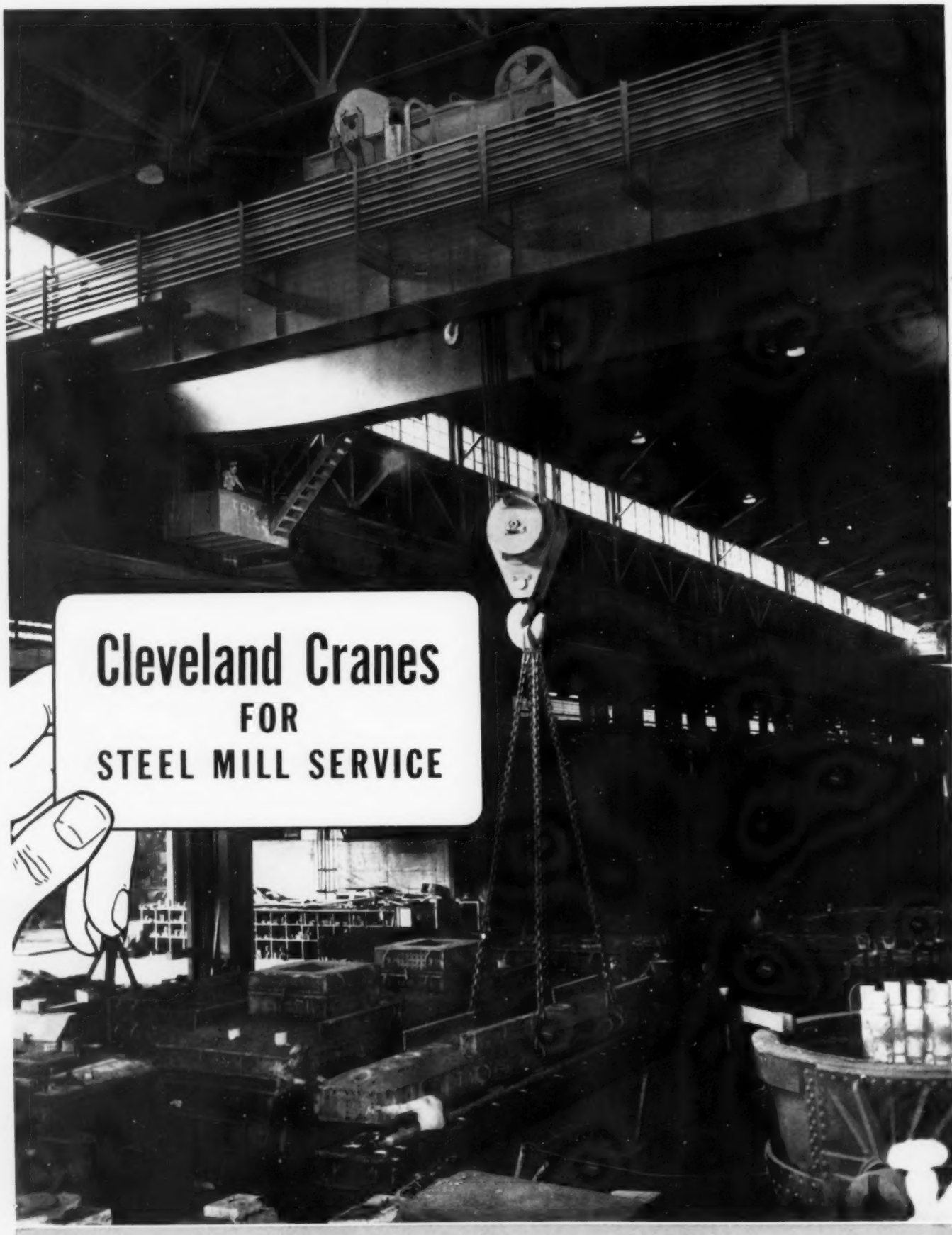


ENGINEERING STUDIES indicate that under identical operating conditions new G-E Class H insulated coils in MD-600 motors will last up to *32 times* as long as conventional Class B coils. Insulation failure may be eliminated as the limiting factor in continuous auxiliary mill motor service.

ACTUAL TEST with Class H and Class B motors coupled together *proves to date* the new insulation will last more than twice as long as the old. After burning out two Class B insulated motors, the one with Class H coils is still operating under exaggerated load, vibration and atmospheric conditions.

Progress Is Our Most Important Product

GENERAL ELECTRIC



CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops and Shorts

THE 1955 AISE convention is over and apparently the 2386 individuals attending enjoyed it and benefited from it. Of course, there were the usual gripes about fumbled reservations, peeled paint and incidents of poor service, but favorable comments were also present in the usual majority.

Again, the convention fell in World Series week, but fortunately, not in a World Series city. Also, the difference in time put the games into the noon recess periods, rather than interfering with the technical sessions.

The Association appreciates the fine cooperation extended by the Sherman Hotel, and extends thanks to all the people who helped to make the affair successful.

▲

AND it couldn't have been conventioneers involved in this brief conversation in the dimly lit cocktail lounge of the Sherman Hotel: "Hands off, Columbus! You've discovered enough for one night."

▲

SOME pressure is developing among steel producers to ban export shipments of scrap, which may run to 5,500,000 tons for 1955, principally No. 1 heavy melting scrap. It is believed that continued exports will lead to drastic shortage and curtailed steel production in the United States. Thus far, the U. S. State Department has opposed the ban, which they think would harm friendly nations.

The scrap industry, however, believes that any restriction on scrap exports should be accompanied by similar curbs on steel.

▲

A recent labor-management agreement introduces a new paid holiday — Christmas Eve day. Holiday pay (triple time) will be paid even when the holiday falls on Saturday or Sunday.

No doubt the next contract will set up a man's birthday as another holiday.

▲

THE Office of Defense Mobilization has closed the expansion goals for electrolytic tinplate, iron ore, by-product coke and metallurgical coal, as well as that for primary aluminum. This eliminates the fast tax write-offs on projects in these fields. The goal for heavy steel plate remains open.

Reopening of the goals for steel ingots, pig iron and structural shapes has been refused.

ODM has on file some 66 applications totaling more than $1,100,000,000.

A friend with an investigational turn of mind says the best way to get a youthful figure is to ask a woman her age.

▲

ACCORDING to the American Iron and Steel Institute, a basic market basket of food costs the American steelworker 1 hour and 38 minutes working time, as compared to 4¾ hours in Great Britain, over 5 hours in Sweden, almost 6½ hours in Germany and 9 hours 51 minutes in France.

The same statistics show that an American steelworker works a little more than 18 hours to earn money to buy a suit of clothes, as against more than 26 hours in 1924. A low priced automobile in 1924 required 1065 hours of work, but only 431 hours in 1954.

▲

ALMOST 4,000,000,000 pounds of frozen foods were sold in 1954, and it is expected that, by 1960, frozen foods will account for 10 per cent of chain store income — and a lot of frozen foods don't use tin cans.

▲

NEVERTHELESS, tin plate shipments for the first of 1955 totaled 3,175,198 tons. Significantly, more than 80 per cent of this was electrolytically coated.

▲

FROM Better Farming:

Those girls who buy
Their form divine
Should dry them on
An inside line.

▲

TOTAL research expenditures in the United States over the past 25 years have been estimated at $30,000,000,000 and gave an estimated return of 13 for one during that time.

▲

IF a man is known by the company he keeps, is a good man bad because he keeps company with a bad man or is a bad man good because he keeps company with a good man?

▲

E. T. WEIR, chairman of National Steel Corp., told the Cleveland Society of Security Analysts: "The replacement of existing properties, which will have to be made over the next 25 to 30 years, will be on a cost basis as high as today's or higher. If it is to cover these costs, the steel industry must charge off considerably larger amounts for depreciation than it is charging now. To do this, and at the same time be able to finance the building of additional capacity, I believe it is obvious that steel prices must be higher if the steel industry is to have an earnings base capable of supporting this program."

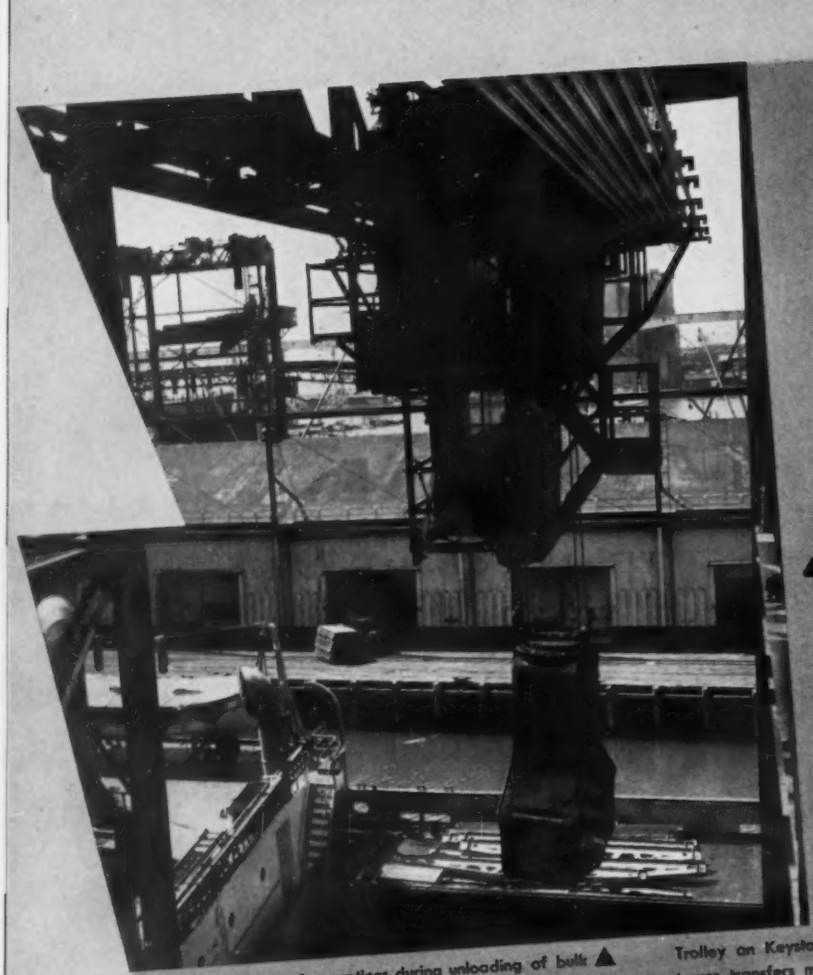
▲

SIGNS of the times:

On a florist's truck: "Drive carefully or the next load may be yours."

A Japanese road sign: "Please drive carefully. Our children may be disobeying us."

Unloads with GREATER SPEED... LESS



with KEYSTONE

Bird's-eye view of operations during unloading of bulk materials at Port Covington, Baltimore Harbor. ▲

Trolley on Keystone Aluminum Conductor-equipped tower transfers miscellaneous bulk cargo from ship holds to waiting freight cars. ▼

▲ Close-up of trolley cab and Keystone Aluminum Conductor System, including collectors and insulators.

ELECTRIC SERVICE MFG. CO

MAINTENANCE...
INCREASED TONNAGE...
FEWER INTERRUPTIONS...

Integrated Aluminum Conductors

at **Western Maryland Railway**

FASTER, more economical handling of ore and other materials has resulted from replacement, with a KEYSTONE Integrated Aluminum System, of all old trolley conductors on the double-apron unloading tower at the Western Maryland Railway docks at Port Covington, Baltimore Harbor.

SPEEDY CARGO TRANSFER from ship-to-shore is important in getting highly competitive ore-unloading business along the Eastern Seaboard. Ship operators want fast unloading, to give them quick ship turn-around . . . less time for ships in port . . . more time for profitable cargo-carrying.

TO SPEED turn-around, Western Maryland Railway modernized its facilities by replacing old copper and steel conductors with Keystone aluminum a year ago. Benefits resulting from it are:

Higher Speeds **. . . no longer a need to "trolley" at low speed to avoid breakdowns; greater efficiency in power conductor gives unloader more "pickup" capacity.**

Fewer Work Stoppages **. . . new conductors eliminate frequent breakdowns and derailments.**

Greater Tonnage **. . . from overall greater efficiency; more ships now unloaded without proportionate increase in cost.**

Cheaper Maintenance **. . . due to fewer conductor breakdowns while unloading; upkeep reduced to regularly scheduled, less costly preventive maintenance. Equipment burnouts sharply reduced.**

Why THE KEYSTONE INTEGRATED ALUMINUM CONDUCTOR SYSTEM GIVES LONGER, BETTER SERVICE

Durable — Aluminum lasts longer in destructive atmospheres. Contact surfaces stay smoother and cleaner than steel . . . prolong shoe life. Multiple contact collectors prevent arcing and heating. Less vibrating weight saves insulators.

Lightweight — Permits prefabrication of units, to reduce cost of installation, insulators and supporting structures. Compact design saves space, permits better protection with standard enclosures.

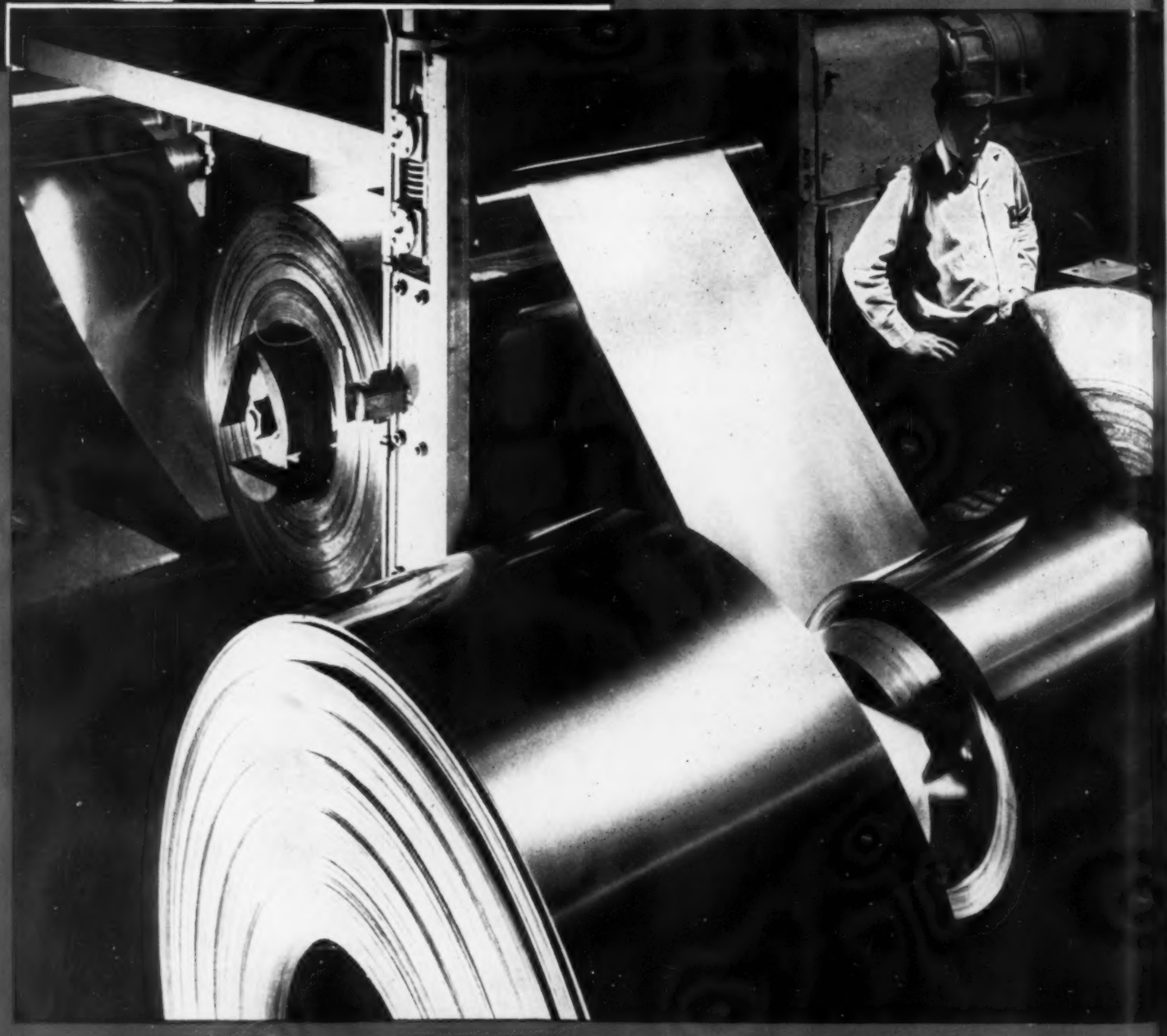
Voltage and Capacity — Non-magnetic aluminum increases current capacity through lower reactance, and permits closer conductor spacings. Ample capacity for other equipment without need for boosters or multi-point feeds. Pre-engineered systems now operating to 6000 amp capacity.

Write today for Booklet 439 on Keystone Integrated Aluminum Conductor Systems.

Philadelphia 32, Pa.

The WEAN ENGINEERING Company, Inc.

WARREN, OHIO



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Iron and Steel Engineer

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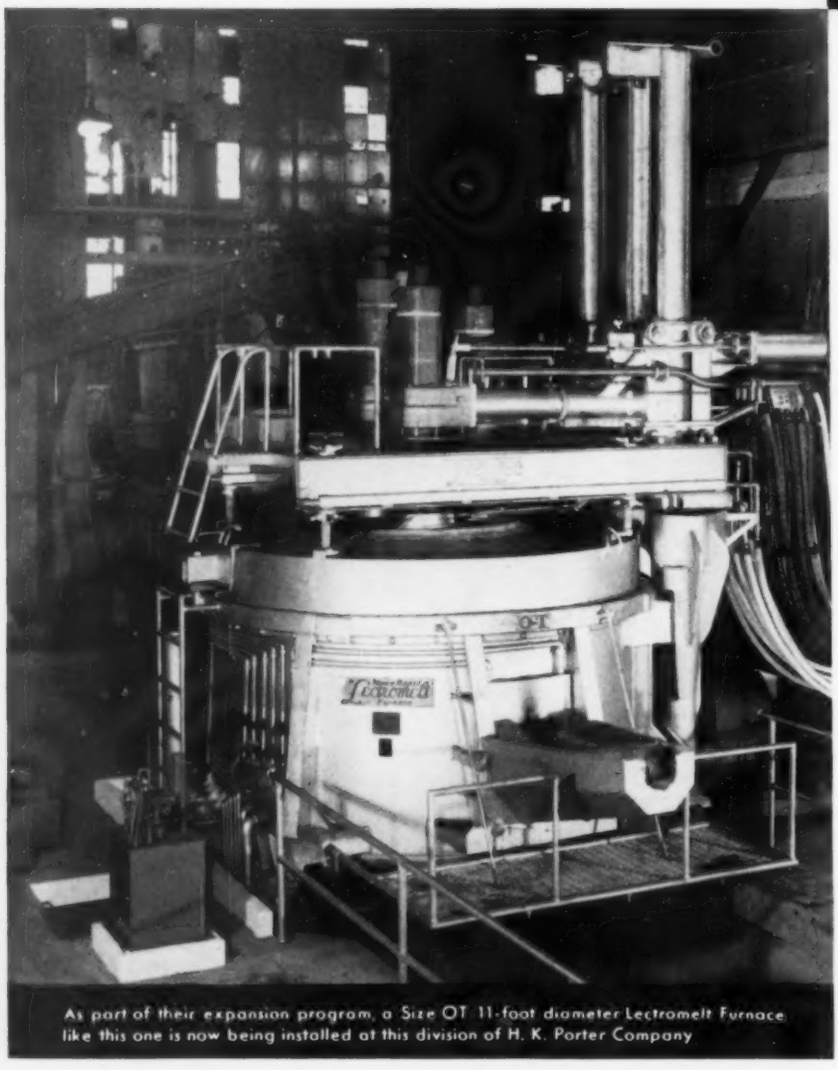
PLASTIC BINDING U. S. PATENT NO. 1970285 LICENSE NO. 170

Success in producing billet-size ingots with their Lectromelt* Furnaces causes Connors Steel to add another

Stripping billet-size ingots at Connors Steel, Birmingham, Alabama.



As part of their expansion program, a Size OT 11-foot diameter Lectromelt Furnace like this one is now being installed at this division of H. K. Porter Company

● "We've bought a fourth Lectromelt Furnace because we're 100% satisfied with our three previous Lectromelts", reports Mr. J. B. Reeves, Works Manager for Connors Steel Division, H. K. Porter Co., Inc. of Pittsburgh, Pa. "We cast 4″ to 8″ billet-size ingots, thereby by-passing any need for soaking pits and a blooming mill."

Billet-size ingots solidify rapidly, resulting in uniformity and fine grain structure. Merchant shapes and reinforcing bars are produced from them now at Connors Steel, with cold finished bars to be added early in 1956.

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Catalog No. 9-A describes Lectromelt Furnaces for all metal melting and refining work. For a free copy, write Pittsburgh Lectromelt Furnace Corporation, 310 32nd Street, Pittsburgh 30, Pennsylvania.

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*REG. T. M. U. S PAT OFF

MOORE RAPID

WHEN YOU MELT... *Lectromelt*

Function of the Engineering Department in a Steel Plant

By F. C. SCHOEN
Chief Engineer
Alan Wood Steel Co.
Conshohocken, Pa.

. . . . the function of the engineering department in the steel plant is to give service to all who require it . . . .

▲ IN assembling information for this paper, there were many surprises as to the variety of ways engineering departments function. As a result an attempt has been made to put this information in some order and draw some conclusions covering what is believed would be the best functions for the engineering department in a steel plant.

This discussion is confined to the smaller plants employing from 1000 to 5000 people. This does not mean that many of the statements mentioned would not apply to larger plants. The discussion is also confined to engineering departments whose work has less than 10 per cent time devoted to product engineering, leaving 90 per cent or better for general plant work, surveys, maintenance, construction, improvement programs, etc.

To start with, the function of the engineering department, and perhaps the most important function, is to give service, the engineering department is a service department.

To illustrate this point, look at the following organization charts—showing where engineering departments are found in various plants, and it is seen that in most cases, engineering is a staff function (or service). See Figures 1, 2, 3, and 4.

Using the premise that the function of engineering is to give service, the following will attempt to show how to get the best, or at least, the most service from the department.

To do this, re-examine the charts and try to tabulate the advantages and disadvantages of each.

In Figure 1, engineering is shown as a staff function reporting to the vice president, and on an organization chart basis at the same level as works manager. The possible advantages and disadvantages could be:

Advantages

1. Quite necessary if the department services more than one division.
2. Broader scope and broader view of management planning.
3. Less possibility of shading reports on a specific condition.
4. Possible savings to the company due to the knowledge of equipment going out of service which may be useable in another division.

Disadvantages

1. Works manager may not get the service he believes necessary.

In Figure 2, engineering is shown as a staff function reporting to works manager—if there is only one division to be covered all remarks under Figure 1 would apply, however, at this point an additional item may be encountered, namely the purchasing department which still reports to top management and with this addition to the chart, are found more potential disadvantages and advantages.

Disadvantages

1. Unequal authority regarding specifications, etc., on engineered jobs or contracts.
2. Good engineering methods are harder to enforce.

Advantages

1. Closer to job—in time of trouble—may give faster service.

If—and this does not apply in some instances, Figure 2 has another addition—as shown in Figure 3—the dis-

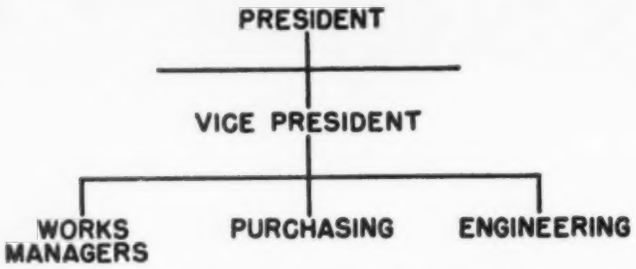

Figure 1 — In this organization, engineering is put on the same level as purchasing and operation, working directly under the vice president.

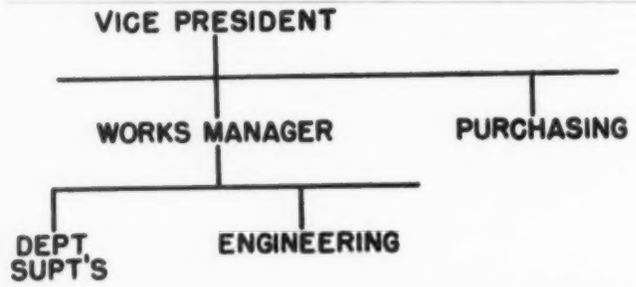

Figure 2 — In this organization, engineering is put under the works manager and on the same level as the operating superintendents, with purchasing at a higher level.

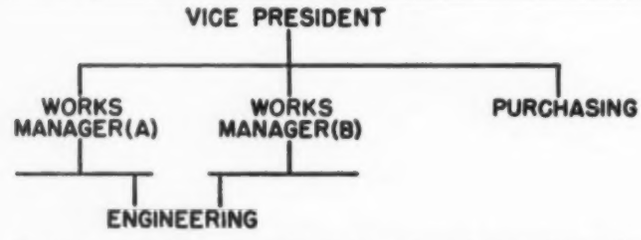

Figure 3 — In this arrangement, engineering works under several works managers.

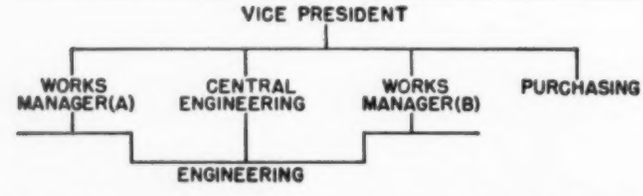

Figure 4 — This organization chart puts a central engineering group under the vice president with subgroups assigned to operations.

advantages are obvious—a referee is needed and engineering is in the middle—just as much as in Figure 4. Although under this arrangement, departmental work is perhaps more flexible than in Figure 3 in that a portion of force is assigned to each division—with a central engineering group available for assignment where work is heaviest.

There are many more charts which could be illustrated—the four used being typical, but in nearly every case we still find engineering a staff function.

Examining then the four charts given and weighing advantages and disadvantages, we propose to use Figure 1 as being (at least on paper) the organizational arrangement which is the most useful.

With this chart in which engineering is a staff function, let us examine its relationships with other departments—purchasing, maintenance, operating and accounting.

What are the relationships with these departments?

What relationships would be of most benefit to the company?

Since we are assuming engineering is a service group, we will discuss first the relationship with the operating departments, the departments which support us.

Operating departments—For the purpose of this discussion we will call operating, the production departments with their superintendents.

What are the possible relationships between engineering and operating?

Is the engineering department a necessary nuisance that department superintendents must go to for some things because that is plant procedure, otherwise to be avoided whenever possible?

Is it a place to lay the blame or pass the buck for a job that is not done?

How many production departments think only of engineering as a place to get blue prints, and who bother them on new construction?

Let us see what engineering as a service department can do for production or operations.

We will mention in connection with purchasing and maintenance some things which are, at least indirectly, services to the operating group; however, there are other ways a direct service can be rendered.

A department superintendent desires an improvement. An off-the-cuff estimate of cost will help him to decide whether it can be justified.

A product change is desired. Engineering can easily check design to see if it can be done with existing equipment.

We believe that the engineering department is fulfilling one of its functions when its relationships with operating are such that any production superintendent feels that when he picks up the phone to call engineering for help—he gets it. If he wants an engineer to check something he knows the best men available right then will be sent to give him a prompt answer.

Purchasing—We will next examine relationships with other service departments starting with purchasing. We find many times that purchasing feels that engineering should confine itself to making drawings. We also find engineering departments who believe that they *only* are qualified to decide who, and what product or services, should be purchased for jobs they are interested in.

We believe both have arguments in their favor as follows:

Engineering department doing its own purchasing for construction or engineered jobs.

Advantages

1. Saving in time? (Note the question mark.)
2. Easier to make substitutions to meet schedules.
3. Easier to specify one supplier.

Disadvantages

1. Duplications of functions with another department.
2. Less power to effect delivery, due to lower volume of purchases.
3. Could be more costly to company.
4. Less knowledge of suppliers and contracts.

Purchasing department doing all buying.

Advantages

1. Improved pricing on account of quantity discounts.
2. Specialized buyers.
3. Stronger position to effect deliveries.
4. Competition assured.

Disadvantages

1. Loss of time if substitutions need to be made.
2. Less interest in obtaining specified commodity.
3. More work for engineering in checking specifications? (Again note the question mark.)

However, in trying to see where the most benefit will be derived, we will ask and try to answer a few questions.

1. Why a purchasing department?
   Several reasons—by centralizing buying, a program of uniformity with resultant savings is possible.
   By having buyers in specific lines, deliveries, etc., can be helped.
2. What is purchasing department expected to do?
   Possibly most important, it is to buy necessary and specified commodities at lowest cost.

It is this last reason which so often raises a conflict between engineering and purchasing — since many times engineering will try to specify only a particular commodity, which can lead to the accusation of the way engineering "gold plates" a job.

With this in mind we would like to suggest, (and bear in mind we are not talking to large companies with multiple engineering and purchasing departments) the following as a practical relationship between purchasing and engineering.

Engineering to write specifications broad enough to permit competition wherever possible (which is most of the time). When only one commodity is acceptable, which may be for a number of reasons, give purchasing those reasons. Purchasing then obtains competitive prices and engineering checks to see if specifications are met, in turn approving to purchasing—and here, we believe, if prices are unknown to engineering they could do a better job. Purchasing then performs their function of buying at best price—and delivery.

Next, purchasing and engineering working together, especially if delivery is critical, can often by a minor specification change, which could cost more money as well as less, obtain materials and services at the required time.

Another point which must be covered is correspondance with suppliers.

After an order is placed, quite often there are engineering details to settle; approvals to be made, etc. In the interest of saving time, paper and labor we suggest that these matters be handled directly by the engineering department, as long as no changes in prices are involved, with copies of letters going to purchasing. However, if questions arise involving price changes, then engineering should make recommendations for purchasing to authorize such changes.

As you may note we have made the assumption that the purchasing function belongs only to purchasing department and is not a function of engineering.

Maintenance—Here we have some interesting ideas, on interplant relationships. It is not uncommon to hear maintenance discuss engineering as, being out of step, a good place to hold up a job, full of costly ideas, trying to ram jobs down our throats.

We also hear engineering express their views as to the way maintenance cuts up buildings, disregards drawings and specifications.

We are of the opinion that too often engineering forgets they are a service organization, and the reason they exist is to provide a service for someone. Engineering departments do not produce a salable product, but they can provide many services which will help in keeping costs at a point that permits making a profit.

What are these services and where can engineering be of direct service to maintenance?—First and this is obvious—keeping of records, such as drawings, blueprints and specifications—and as far as possible keeping these records accurate, incorporating plant and equipment changes as they are made. From our discussions with many people, we believe it is more common than not, for changes to be made by plant personnel without notifying engineering and for many changes which engineering were told about to be buried in a sub-file and never reach the permanent record. The results of this eventually show up in increased cost, sometimes of repairs or often as an increased cost of a new job, because drawings were issued or estimates prepared without the true facts.

This may be a good place to mention drafting forces. It is not uncommon to find small forces working in and for maintenance departments, and the necessity of these groups are vigorously defended. We cannot say they should not exist, but if engineering gives drafting service required, there should be no reason for such a force. Again, as in the discussion concerning purchasing, it is a duplication of effort and could contribute to the lack of complete information in engineering department records.

The second service of the engineering department again should be obvious, and that is to design for maintenance.

When designing parts for new equipment, buildings, etc., as well as redesigning parts of old equipment, engineering should realize that machinery wears out, breaks, or can be damaged, and therefore must be repaired. If the design is such that installation times are short, that it is easy to take apart and put together, then maintenance has an easier and less costly job to keep the plant running. In designing for maintenance, close cooperation between the departments is a necessity. Maintenance should have and accept the opportunity to examine and approve design, as it affects their work, before drawings are issued, but at the same time engineering must not issue drawings to meet someones desires unless good engineering fundamentals are met.

A third service (and many will question this) is the technical advice available for use in the field. Problems will arise and certainly competent engineers, or specialists who are in the engineering department, should be called on. Not only can they help with their knowledge, but in turn they gain from working with the men who must maintain the plant.

It is difficult to write about relationships between

two service departments, and we have therefore tried to suggest means of obtaining the best. There is no specific list of advantages and disadvantages, but we believe the more the above ideas are used by engineering, the better it performs its service and function.

Accounting—The next department to talk about is accounting.

What possible connection could engineering have with accounting, is asked? Surprisingly, there are quite a few when we stop to look.

Where would engineering be if it could not get costs records on its jobs?

Who would engineering ask for information when working up an economic justification for a job?

What help can engineering give accounting?

The following is a short listing of a few items:

Making of expenditure forecasts.

Life expectancy of buildings and equipment, both new and existing.

Insurance estimates.

Furnishing information on new equipment or modernized equipment prior to putting into operation, for setting up cost centers for accounting control.

Up to this point, we have talked about engineering department relations with other departments and have suggested ways of giving service. If we would stop here, there still are a number of things not covered. What other services can engineering perform and what does management expect or desire from the department?

Naturally the answer to this can vary widely, so possibly a better wording would be: What can management expect or desire from an engineering department? A list could be as follows, excluding items already mentioned:

1. Field engineering service.
   This would apply to new construction, major maintenance jobs, overall building maintenance programs, inspection, general surveys of plant property and equipment.
2. Investigations and reports.
   Specific investigations as required, with written reports and often recommendations. Routine investigations, normally covering the paper work and providing estmates for jobs such as repairs and capital items which are of such a value that management approval is required authorizing the expenditure. This would include keeping such records as are necessary to provide periodic status reports of such work.
   Independent investigations and reports, by this we mean investigating conditions which engineering discovers as a result of other jobs, and making a report for management information. For example, if the company is subject to local community ordinances, discovery of a slight change in plant procedures could effect considerable savings, or a changing load condition on one of the plant utilities, together with knowledge of a future expansion, could lead to an investigation and report that would lead to later savings.
3. Preparation of specifications and details of equipment which may be abandoned, so that purchasing department can offer for sale.
4. Long range planning.
   By this we mean only that while developing a project, due consideration be given to the future, and if this consideration means somewhat increased costs over the actual requirements of the job, management should be advised so that they can make a decision whether or not to spend the money.
   This could apply to utility systems, type of buildings, locations of equipment, and even in some cases size and type of equipment.
5. Studies of new developments or technological improvements, and where these could be applied with benefit in the plant.
6. Participation as a member of group committees, to give engineering information, as well as to have some foreknowledge of plant planning. We are thinking here of such groups—as scale committees, management planning and development committees.
7. Watchdog—and we could not think of a better word to use.
   As an independent staff group it is possible for engineering to see plant production records, maintenance cost records, fuel records, utility figures, and spot conditions which need correction. For instance, overloads on crane ways in open hearth or a sudden increase in sewer bills, possibly even a drastic increase in useage of a particular repair part, and call these things to the attention of those directly interested.
8. Possibly you are asking, what about development of an approved job, making drawings, writing specifications — work which is naturally thought of when speaking of an engineering department? In a sense we have touched on this work already but there is one question constantly raised which should be mentioned, and this is—why do engineering department jobs always cost so much?
   Here are possibly some answers:
   a. Too much engineering and not enough economics. When a job is developed, many times the goal is 100 per cent perfection when actually what the plant wants and can justify is 90 per cent perfection at 50 per cent cost.
   b. Scope of work too vague.
      When making estimates, scope should be definitely detailed and agreed to by department heads who will be affected. Nothing is more disastrous to an estimate than to have change after change creep in after drawings are started. Certainly we recognize, that in final development, changes which affect the original estimate sometimes become necessary, but an increase in scope without full approvals can certainly make an engineering estimate look bad.

The engineering department is performing properly its service function to management if these facts are recognized and so we will conclude this portion of the discussion with the statement.

The function of the engineering department in relation to the management is to gather all of the available facts, tabulate, correlate and present to those who require them.

We will now depart from the functions for awhile and try to answer another question.

How big should the department be and what should be its staff makeup?

Our only answer is, if management expects all of the services we have mentioned, we believe the minimum staff will consist of a civil engineer, electrical engineer, mechanical engineer, field or construction engineer.

Now usually, if the company can support any engineering department at all, it will be headed by a chief and an assistant chief engineer, so the staff could actually consist of three men, providing the chief and assistant were one of the first three mentioned with field work being divided up.

To try and develop the full engineering force we suggest a premise of four or five months work as a backlog. A shorter time than this we believe is insufficient where drawings cannot be started until an appropriation is approved, equipment ordered and manufacturer's drawings received before drafting can be completed.

We have found useful the following method to determine drafting force, and the number of men on staff as engineers will in general be influenced by the size of this force.

First, try to estimate the manhours per operating department required for routine work, such as minor drawing revisions, etc., past experience records being a good guide.

Next, an estimate of manhours of authorized studies or approved jobs is made and finally an estimate, based on knowledge of management planning, etc., of anticipated manhours required for investigations. If the sum of these last two is broken down to the number of men required to do the work in four months plus the number of men required for routine work, there is a fair figure available for total force. We recognize that this group must be further divided into designers, top draftsmen, etc., and the smaller the force the greater must be the proportion of top skill individuals.

We certainly favor the idea of having a small group of good men and using the talents of contract drafting or engineering companies, when a major engineering or plant development program is under way, with the use of the in-plant force as project men, rather than a large increase in the engineering drafting force for what should be considered a temporary job.

Going one step further, in speaking of size organization—we will hazard a guess that many engineering department vaults contain beautiful tracings, complete to the last detail, of jobs that were never done. We suggest as a standard procedure, the practice of never making more than sketch drawings, or flow diagrams for preparation of basic estimates. When estimates are approved and expenditure authorized, then job drawings are started. This is not foolproof as occasionally estimates are missed, but at least it can save many manhours and with a small force can expedite completion of approved work. These last suggestions are not functions, but are stated here as possible guides to an efficient department so that it can perform its service function successfully.

Finally the engineering department can help complete with practical work the training of student engineers as well as graduates right out of school, and then channel these men into other service and operating departments for supervisory trainees.

We have mentioned a number of ways which we believe will make an engineering department more valuable to the company of which it is a part. These suggestions were made to support what we believe is the function of the engineering department in a steel plant; namely—to give service to all who require it.

DISCUSSION

PRESENTED BY

J. A. BELL, Chief Engineer, Bethlehem Steel Co., Bethlehem, Pa.

P. H. PUTNAM, President, Fluid Controls Co., Inc., Philadelphia, Pa.

M. B. ANTRIM, Assistant Manager, Maintenance and Construction Div., Lukens Steel Co., Coatesville, Pa.

F. C. SCHOEN, Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa.

J. A. Bell: Although the paper was confined to smaller plants employing 1000 to 5000 people, if our plant is any criterion, little has been said that does not apply to the engineering departments of larger plants as well. Our relations with purchasing, accounting, operating, and maintenance departments, our problems of keeping records up to date, jobs within the scope of the estimate, etc., are all pretty much the same.

It might be of interest to mention the mechanics with which we face these problems. Our plant engineering department is divided into two parts—a project group and a drafting group. Our project group is responsible for planning, reports, analyses, estimates, preliminary layouts, etc., everything up to appropriation approval. After the approval of the appropriation, our drafting group takes over and makes the design and detail drawings required for construction.

While Mr. Schoen lists four charts showing the organization setup that might apply to various size plants, we will not comment on these charts other than to say it is our contention that engineering should definitely come under manager's office, which in turn reports to the vice president in charge of operations.

One of our biggest problems involves the dividing of authorization between engineering and purchasing departments.

Where standard or duplicate equipment is involved, engineering should have the authority to make a final decision since it involves the best unit for that particular job, interchangeability of parts from a maintenance standpoint, and knowledge of past performance.

Purchasing department could, however, advise engineering the reason for their preference, and allow engineering to voice an opinion before making their final choice.

In many instances units have failed in service where purchasing has insisted on buying from a certain vendor for other reasons than satisfactory past performance.

A few questions: First, you mentioned that engineering might do a better job of selecting purchased equipment if the prices thereof were unknown. Do you think it is possible to divorce cost from engineering—after all, a Cadillac will fit the specifications for an automobile but you may have only a Chevrolet job or purse. Secondly, in regard to the keeping of records, we insist that all proposed sites be carefully surveyed by our civil squad so that we know actual field conditions as opposed to taking information from old drawings and records. It is our belief that no matter how good a record keeping system might be, that field surveys must be taken if expensive errors are to be avoided. Have you given any thought to the cost of record keeping—and the attendant difficulties of doing so—versus the cost of field surveys?

In connection with this, I might mention that we are now on the home stretch of a big construction program on which we have been rather fortunate in not running into too many obstacles underground which were never recorded. This was not the case in years past. It was particularly true in regard to sewers, and small water lines, etc., the reason being that years ago —and I can pretty well speak from experience on this —there was a tendency among construction people to put in jobs that did not conform to the drawings of the engineering department, only to cause considerable trouble on new construction. At the present time, our system is this: if a change is made in the field during construction, a note is made of that change and we are informed of the construction, a note is made of that change, and we are informed of the items involved, by letter. We immediately assign a man to making those corrections on the drawings so we at least have an up-to-date record.

P. H. Putnam: I am a vendor. I have a few comments to make but I think it might be of interest to say, No. 1, that most vendors who walk into the steel plant are interested in doing a job for the company that they are walking into—not necessarily only the manufacturer they represent. I think most of them that come into a steel plant are interested in that steel plant's problems, but they have problems, too, and that is their relationship between engineering, operating and purchasing departments. If we give prices to engineering, we may be criticized by purchasing. If we give data to the operating department, we may offend engineering. I would like to see more cooperation between the three departments. I am in hot water in many plants I go to because of that, which results from trying to do the best job possible for both my principal and my customer. One other point I would like to ask that is why, when most engineering departments go ahead with a project, it is finally authorized, and money is available, the most unrealistic schedules are set up under pressure from management. However, engineers, operating men and vendors that sell equipment know these dates cannot be met, but still everybody agrees to meet them.

Now, in some of the larger companies—and this is not usually true of the smaller ones—some of the engineering personnel who are responsible for writing specifications have not had sufficient operating experience and they are a little bit disinclined to accept recommendations from the operating and maintenance departments who have to live with that equipment. Consequently, quite often, suppliers are allowed to bid who do not have the necessary experience, or the necessary background, yet they are considered acceptable bidders; therefore, reliable bidders have to cut prices or else lose business and everybody gets in trouble.

And once again I believe the author brought out clearly about the purchasing department having priority over engineering. I know of several fairly big jobs that had troubles because industrial relations or purchasing made the decisions, on a reciprocity or price basis. In fact, I know of one particular job where a company lost the job on the basis of $49,000 difference on a $250,000 bid. Today, the purchaser company is budgeting $400,000 to replace the equipment they bought. In this case, engineering recommended that the right equipment be bought, but were overruled. That costs money. I agree with Mr. Bell's advice, the engineering department should have the final say.

M. B. Antrim: At the risk of some over-simplification, I would like to prescribe a remedy. It seems to me that most of the things which have been mentioned by Mr. Schoen and Mr. P. H. Putnam come about through arbitrary decisions being made by some one or some group. They come about through a non-understanding of the other fellow's problems, and they come about through personal animosities which exist in every company, be it large or small. Now we are all engineers, we went to school and we spent a long time and had a good bit of experience, and it seems as if anybody is qualified to make a mature decision, it ought to be we engineers. Therefore, it is somewhat incomprehensible that we should allow ourselves to get in any of the positions described. It seems as though we should be able to get along with anybody at the same time attaining correct and justifiable ends and it would also seem as though any mature management ought to insist upon it.

F. C. Schoen: Mr. Bell asked a couple of questions, the first was on the effect of prices in engineering and the statement that we believe we could do a better job if we do not know anything about prices. I still feel that way. We can interpret the proposals and on the basis of the drawings that are submitted, the weights of the material, taking into account past performance, and on these things approve certain specifications as being acceptable to engineering. The acceptable proposals might be the highest or might be the lowest price, but if you do not know the cost, you are not going to shade your judgment in reading those proposals as much as you might if you knew the cost. That is why I made the statement that I did. The second question was on the cost of record keeping vs field surveys. No, we have made no cost estimates on that, but I believe where you can get in possibly the most trouble under the method proposed, with defective drawings, is on your preliminary estimate. You may think that if you

made a preliminary estimate based on existing drawings, that you could put certain things at certain places. You get your job authority and then you start to survey the sites and find you cannot do what you thought you were going to be able to do. Possibly, Mr. Bell has his surveyors survey the sites and do everything, even on the very small jobs. I would say we do the same on a major project, but it is surprising how many $2500 jobs can end up costing $10,000 and I suppose those are the ones that cost the company most in the long run.

I did not bring Alan Wood into the paper, but one thing we are trying to do at Alan Wood I have found quite desirable: We have adopted a practice wherever possible of having the draftsman or the designer, who lays out the job, finding himself out in the field installing that job. He is a better man for it. Sure, he is going to make mistakes, but he is not going to make them a second time, and he has a better idea of what the field problems are the next time he makes a drawing.

Mr. Putnam brought up an interesting point. That is why they have engineering departments and purchasing departments. Things drift along, we all know, until the management suddenly decides they have waited six months too long before they authorized this job and then they want it tomorrow. That is one of the reasons cooperation between purchasing and operators and engineering is necessary.

I mentioned that we can change specifications slightly. Maybe we find out we can get this piece of equipment by making a slight change that is still going to do what we want it to do, that helps delivery. All these things go together. The suppliers are cooperative. We somehow always manage to pull a job through on schedule although it may be very tight when we start.

The other thought that Mr. Putnam mentioned was submitting something to engineering that the operators did not like. We mentioned that we believed maintenance should have a part in approving drawings for work that they are interested in. We also believe that the operating department as well as maintenance must have a voice in what they are getting on new equipment, because they are the people who have to run it, and if we cannot satisfy the men that have to run the equipment we are not doing our job.

As to the matter of reciprocity, I do not believe any engineering department or purchasing department is too much involved or has too much to say about reciprocity. It is still a management function. You certainly are going to recommend what best meets the job, you are going to approve specifications, but there are still some things that management knows that we in engineering and purchasing do not know anything about, so when we start talking reciprocity, we are just out of the picture.

Mr. Bell, you wondered why we had so many problems. I did not say we had problems. I listed a lot of things which might be a problem in Plant A, others which might be a problem in Plant B, etc., but actually what I tried to do in working up the paper was to stress and carry through the entire paper the idea that cooperation is a necessity. If you have that cooperation you do not have any problems.

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AISE CONVENTION AND EXPOSITION

CLEVELAND, OHIO

SEPTEMBER 25, 26, 27, 28

Design and Construction of transformers for the steel industry

. . . . desirable features in transformers such as low losses and low temperature rise, large safety factors and mechanical stability are obtained only at the expense of size, weight, and cost . . . . careful analysis of all problems is therefore necessary so that maximum economy can be obtained without sacrificing reliability and performance . . . .

By W. WALTER RENBERG
Electrical Design Engineer
Pennsylvania Transformer Co.
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▲ A discussion of the design and construction of power transformers for the steel industry should begin with an acknowledgement that the steel industry itself has been partly responsible for many of the improvements and advancements of recent years. The transformer industry is dependent upon steel not only for most structural materials, but for vital magnetic components as well.

In the simplest terms, a transformer consists of two current-carrying coils, linked magnetically so that electric power may be applied at one voltage and utilized at another. The core, which is made of electrical sheet steel laminations, might be called the "heart" of the transformer, since it provides the efficient magnetic linkage that makes possible the modern power transformer. In addition to the core, the internal supporting structure for the core and coils is made of steel, and the tank which encloses the core-and-coil assembly is fabricated from steel plate.

It is obvious, then, that transformer manufacturers are heavily indebted to the steel industry, but of course today's highly electrified steel mills would hardly be feasible if transformers did not exist—and if design changes did not keep pace with changing needs.

Transformers for steel mill application can be considered in three groups: power supply units, electric furnace transformers, and those used at load-centers in the power distribution system. Today's electric power transmission and distribution systems require transformers which "stepup" the generated voltage to the transmission level, and others which "step down" the transmission voltage to the customer's requirements.

While some steel mills may generate a portion of the power they require, at least part of the load is usually supplied by the local utility. Several papers have been written about the problems involved in supplying power to electric arc furnace installations. The electric furnace user is a desirable utility customer from the standpoint of the large amount of power consumed and the high load factor, but the fluctuating nature of this load may create supply problems. During the early part of the melt, the current drawn by the furnace may fluctuate rapidly until the charge becomes completely molten. This varying current through the impedance of that part of the power company's system ahead of the point of service causes voltage variations or "flicker," which may be objectionable to other customers served from the same supply. One solution may be to connect the furnace load to the system at a point which is electrically nearer the source. Since the system impedance will be lower, tl voltage fluctuations will be reduced. This solution, however, usually requires a separate transformer to step down the voltage from the transmission level. Because it serves only the steel plant, this transformer may be owned either by the steel company or by the utility, depending on local circumstances. In either case, this unit is a vital link in the power supply to the mill, and its design features are a matter of interest to the steel company's engineers.

Improvements in the equipment and methods used in electric furnace steel production have made this method competitive with open hearth production if the prices of scrap and power are favorable. This factor, along with the increased flexibility and improved metallurgical control, accounts for the increased popularity of electric furnaces today. The design of the

transformers used to supply these furnaces is complicated by the requirement for heavy currents at low voltages. The heavy duty nature of the service demands a well-balanced electrical design and a rugged mechanical structure.

The equipment which uses electric power in the modern steel plant—such as rolling mill drives, material handling facilities, etc., is widely scattered throughout the plant. In order to avoid the voltage drops and the losses which result from long runs of low voltage bus from a single substation, the load center transformer has been developed. A number of

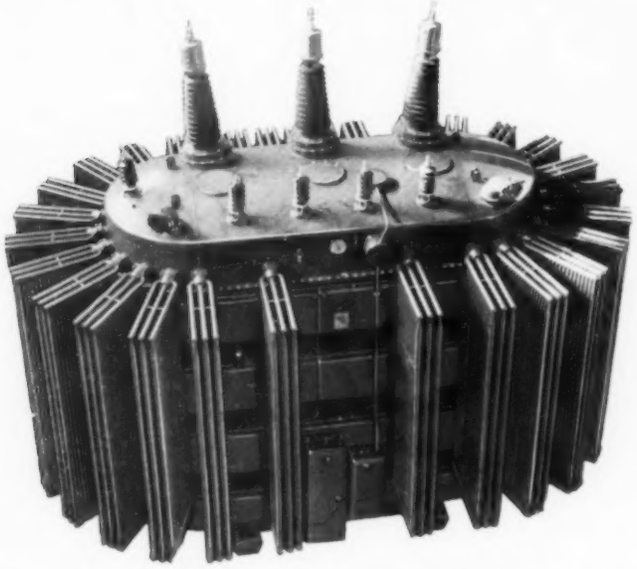


Figure 1 — This 37,500-kw transformer steps down a transmission voltage of 132,000 volts to 24,000 volts.

these units are located at strategic points throughout the plant, to step down the plant supply voltage to the utilization voltage required in each area. Safety is an important factor in such indoor operations, and many special design considerations are necessary to overcome this problem.

There are five basic circuits to consider in discussing the design and construction of transformers. These are the electric circuit or the coils, the magnetic circuit consisting of the core, the dielectric circuit which is the insulation, the thermal circuit or cooling system, and the mechanical circuit which is the supporting, clamping and housing structure of the transformer. All five of these are found in every transformer, but, depending on the application, the problems associated with each circuit may vary widely.

Power supply transformers furnished to the steel industry in recent years by our company have ranged in size from 12,500 to 37,500 kva. Figure 1 shows a 37,500-kva, 3-phase unit which steps down the transmission voltage of 132,000 volts to a 24,000-volt system. Core form construction is well adapted to units in this range of sizes, although shell form construction might be used if larger sizes or special winding arrangements are required. The coils of each phase of a core form transformer are essentially concentric cylinders which surround the greater portion of the core. Figure 2 shows the internal construction of the same 37,500-kva unit and is typical of large core form transformers.

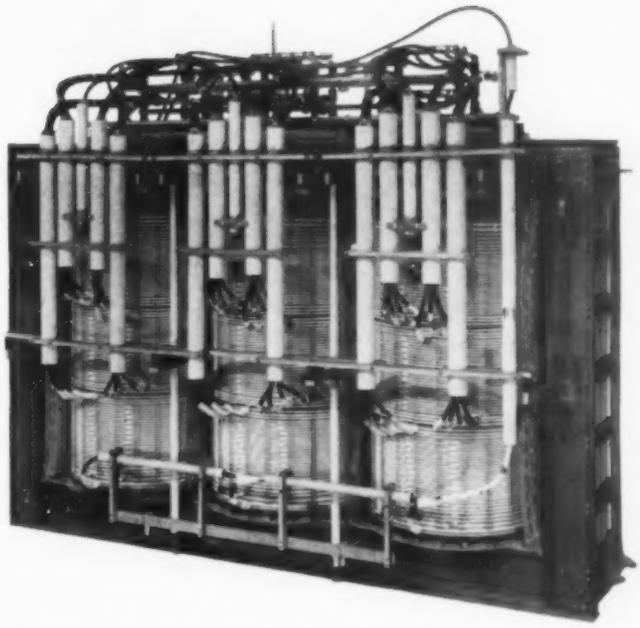
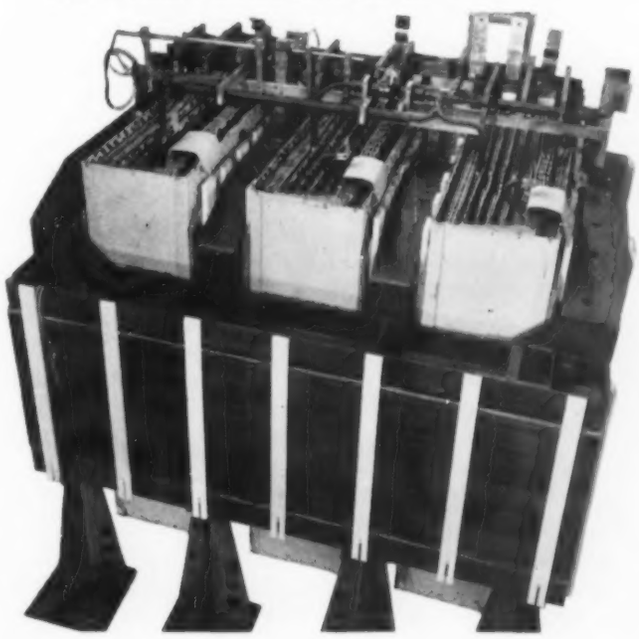


Figure 2 — Internal construction of transformer in Figure 1 is typical of large core form transformers.

Each of the windings of a shell form transformer is made up of several flat, disc-type coils. These coils are arranged parallel to each other and are interleaved in various winding arrangements, with a portion of the core extending through the coils and the balance forming a "shell" around the coils. Figure 3 illustrates this construction in a 120,000-kva generating station transformer. The shell form design is preferable for very large units such as those used at generating stations, but for the medium sized units required by most steel plants, we feel that the core form transformer is a simpler and more economical construction.

Reliable performance and minimum operating costs are probably the most important requirements for

Figure 3 — Core-and-coil assembly of a 120,000-kva shell form transformer (three-phase; high voltage 145,000 Grd. Y volts, low voltage 19,800 volts).



these power supply units. Even a short power interruption during pouring or rolling operations may ruin a large quantity of steel, while a power failure of any duration may mean an expensive shutdown. The transformer's losses determine the day-to-day operating costs, but easy maintenance and freedom from repairs reduce the long-term costs. Reliable performance is assured by adequate cooling, properly designed insulation, high quality materials, and careful workmanship, while losses are reduced by making the optimum use of present day materials.

Probably the most important recent development in transformer materials has been the introduction of cold-rolled, grain-oriented electrical sheet steel for use in the transformer's magnetic circuit. This development is the latest step in a series of improvements in electric sheet steel which began shortly after 1900 with

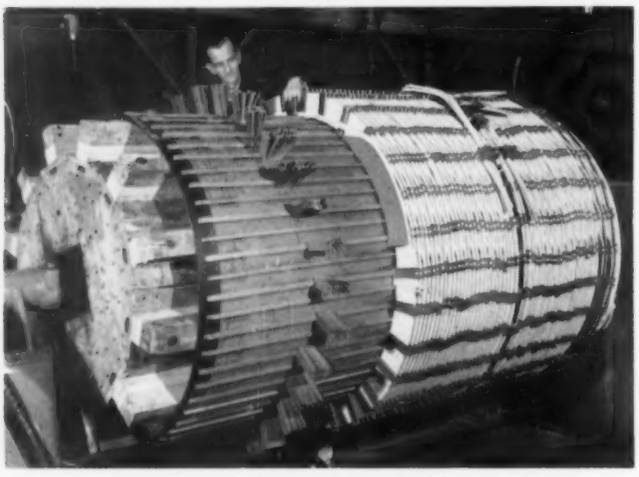


Figure 4 — Winding a "pancake" high voltage coil.

the addition of a small percentage of silicon in the steel manufacturing process. Before this time, the steel had a tendency to age with use, causing the transformer to overheat due to the higher core loss. This deteriorated the insulation and sometimes caused breakdowns.

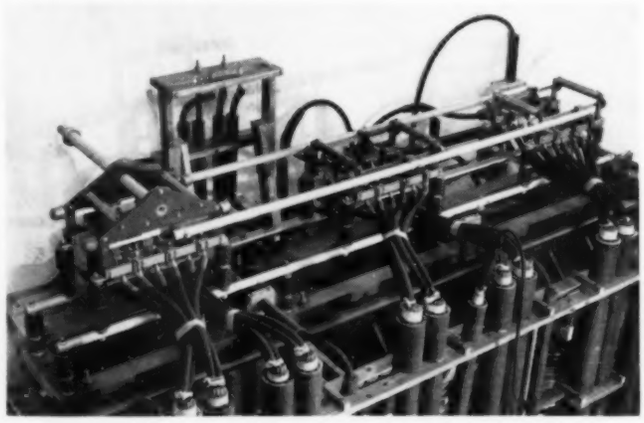
Other improvements in core steel were largely due to the use of electrically heated annealing furnaces, the use of controlled atmosphere during the annealing cycle, improved rolling techniques and improved quality control. In recent years it has been found that the core steel can be more easily magnetized if the individual magnetic crystals of the material are oriented in the direction of magnetization. This cold-rolling process results in a structure in which the individual crystals are alined in the direction of cooling. When this steel is used so that the magnetic flux is parallel to the grain, it may be operated at a higher flux density with the same core loss, thus reducing the size and weight of the core; or, the same size core can be used and a lower core loss will be obtained. Today, steels are available which permit flux densities from 15 to 20 per cent higher than could be used with hot-rolled steel. Twenty-nine gage sheets are used for the core laminations in order to reduce the eddy current losses. This would be pointless, however, unless the laminations were insulated from each other. The manufacturers of cold-rolled steel have developed a surface treatment which gives excellent inter-lamination resistance and which results in a greatly improved space factor for transformer cores.

The electric circuit also benefits from the introduction of cold-rolled steel. The greatest overall economy is obtained when the transformer designer works the steel at a higher flux density and thus is able to use a smaller, lighter core. Since the turns of the windings which make up the electric circuit surround the core legs, less copper is required and the losses due to the resistance of the windings are reduced. Furthermore, a smaller tank and less insulating oil will be required, so that an overall reduction in size and weight is achieved along with better performance.

The power supply transformers purchased by steel manufacturers generally require a high voltage winding in the 69, 115 or 138-kv voltage class, which usually is stepped down to either a 15-kv or a 25-kv system. The "pancake" type of construction is normally used for the high voltage winding. Figure 4 shows a coil of this type being wound. The individual "pancakes" or sections consist of a number of turns which, by use of an ingenious winding method, can be wound from a continuous length of wire. The sections are separated by pressboard radial spacers which form liberal horizontal insulating ducts for the circulation of the cooling oil. The surfaces of these spacers are precoated with an adhesive which serves as an effective bonding agent after proper curing. During this treatment, the entire stack of sections is clamped rigidly together and heated to the temperature necessary to remove the moisture and firmly bond together the entire winding. This method of bonding is a patented feature of our transformers.

The low voltage windings of this type of transformer are usually of the "helical" design. As the name suggests, the winding is a continuous helix, and the individual turns are separated by radial spacers similar to those used between sections of the high voltage winding. The turn normally consists of a number of square or rectangular wires connected in parallel and arranged two wires high by several wires wide in the radial direction. The purpose of subdividing the turn into several strands is to minimize the eddy losses set up by the magnetic leakage field. The strength of this leakage field varies at different points, and unless the individual strands of wire are rearranged or "transposed"

Figure 5 — This straight line tap changer is designed for operation when the transformer is deenergized. The unit shown is 138 kv.



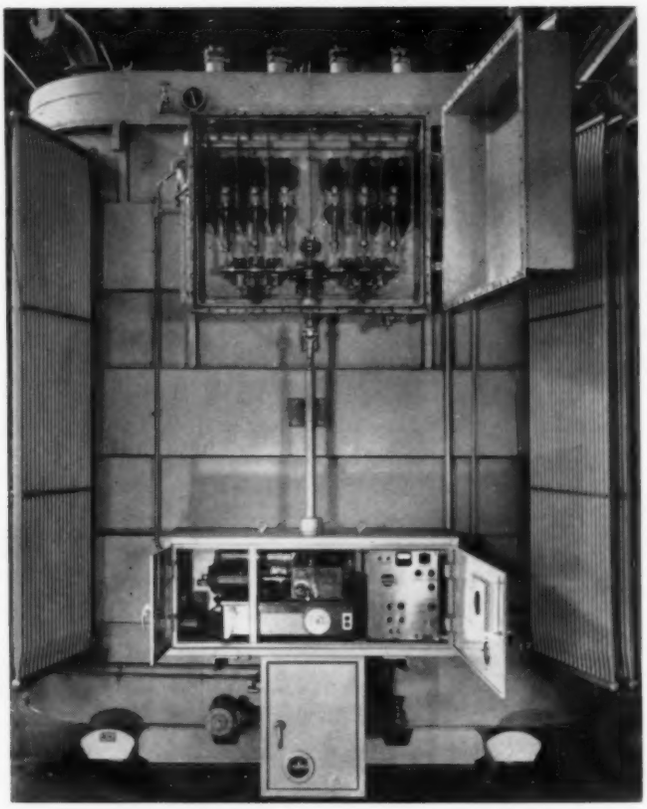


Figure 6 — Transformer is equipped with load tap changing equipment for plus or minus 10 per cent regulation in 32 steps of ⅝ per cent (12,000/20,000 kva, three-phase; high voltage 115,000 delta volts, low voltage 13,800Y/8000 volts; OA/FOA).

so that the effect of the leakage field is equalized, a difference of potential will exist between the strands. The potential difference will produce a circulating current and result in excessive copper losses. For physical strength, the low voltage coils are dipped in heat reactive varnish and baked to cure the varnish.

Generally, the high voltage winding is equipped with taps to permit varying the ratio between the windings as required. It is common to provide five positions and a high voltage tap range of 10 per cent, with a tap changer designed for operation only when the transformer is de-energized. Figure 5 shows the installation of this type of tap changer and the leads coming from the taps in the windings.

Where the load is variable and it is necessary to maintain a uniform voltage level without service interruptions, the transformers can be designed for load tap changing equipment. Figure 6 shows a transformer equipped for this type of operation. If desired, voltage sensitive relays can be used for automatic operation of the tap changing equipment, although this type of equipment seldom is required for steel plant instal'ations.

The insulation which makes up the dielectric circuit takes several forms. High quality manila rope paper wrapped on the wire provides the required insulation between turns. Cylindrical barriers wound from thin pressboard sheets insulate the low voltage winding from ground and from the high voltage winding. Combinations of pressboard washers and collars are used to provide insulation to ground at the ends of the winding. In addition to the continuous stress on the insulation due to normal operation, the design must be adequate to withstand the extremely large voltage surges which may be due to switching operations or lightning strokes on the system. Progress in the proper application of insulation is largely due to better understanding of the nature and effect of such surge voltages. Modern testing and measuring equipment has contributed greatly to the research on this problem.

The impulse voltage generator, which is able to produce voltage surges of several million volts magnitude, is used extensively to determine the effect of these surges on insulation structures and also to proof test completed transformers. The transient analyzer duplicates the form of the voltage surge, at a reduced voltage, and by repeating the surge at very rapid intervals it produces an oscillographic record of the voltage at any test point in the winding. Studies with these devices have shown that the capacitances and inductances of the windings determine the stresses which exist at various points and that different arrangements of insulation may be required to withstand surge voltages than those required by sixty-cycle voltages. For

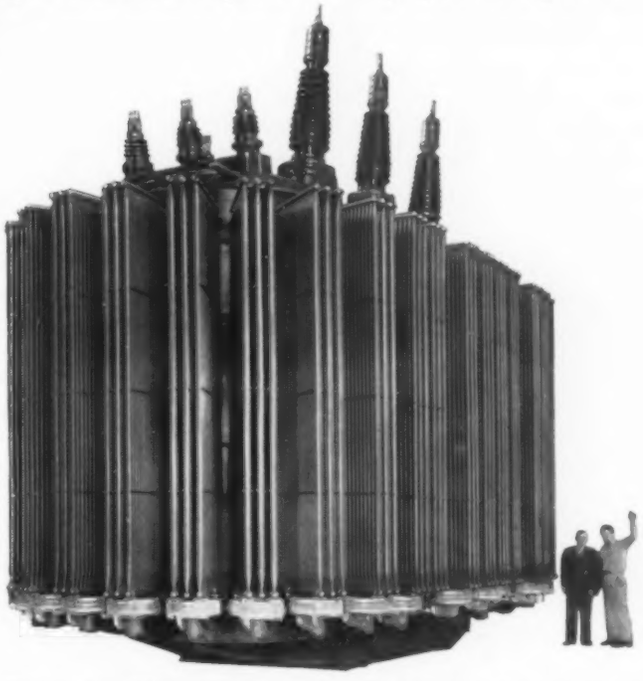


Figure 7 — Most power supply transformers are cooled by means of external radiators. The addition of fans, as shown here, increases the capacity of the transformer.

example, it is known that for certain shapes of the electrostatic field, insulation which will stand up under the required sixty-cycle stresses may fail due to creepage along the surface when a surge is applied. Consequently, in such areas, the insulation is arranged so that breakdown is only possible if a puncture of solid insulation occurs, and the puncture strength of the insulation is made high enough to withstand any possible stress that might be developed in that area.

It is obvious that the insulation of the dielectric circuit must be maintained in good condition to avoid failures. The greatest enemy to the life of insulation is excessive heat. Transformer standards limit the aver-

age copper temperature rise above ambient to 55 C. The hottest spot in the windings may be 10 C hotter than the average copper. With a maximum ambient temperature of 40 C, the hottest spot can thus reach 105 C. Experiments have shown that for each 8 C increase in temperature above 105 C, the insulation life will be cut in half. Cooling is provided on most power supply transformers by means of external radiators mounted around the periphery of the tank as shown in Figure 7. The oil circulates through the tubes of these radiators by natural thermosiphen action and the heat is dissipated to the surrounding atmosphere. The capacity of the transformers can be increased by providing fans below the radiators such as those show in this illustration. This increases the circulation of air around the tubes, which results in more efficient cooling.

In order to cool the windings and the core effectively and to avoid excessive hot spots, the cooling ducts must be carefully proportioned to provide an even circulation of the oil through all parts of the transformer. In some cases, a forced-oil cooling system may be used. Pumps are used to remove hot oil from the top of the transformer and circulate it through heat exchangers and then back into the bottom of the unit. The heat exchanger may be an oil-to-air or an oil-to-water unit. The temperature rise of the oil can be held at a lower figure with this type of cooling than is economical for a self-cooled unit. Also, the gradients of the core and windings are reduced due to the increased circulation rate through the cooling ducts. These two factors permit higher current densities in the windings and a considerably smaller transformer at a lower price. For example, a 75,000-kva transformer in the 138-kv voltage class weighs about 100,000 pounds less and is 30 per cent cheaper when forced-oil cooling is used. However, the total losses are about 130 kw higher than those of a comparable self-cooled unit, and the impedance is 12.75 per cent instead of 8.5. In general, forced-oil cooling is used only for very large units, and is particularly suitable for the shell form construction. Since the winding ducts are vertical in the shell form unit, a natural path for the forced circulation is provided, and the enclosing core and tank prevent the oil stream from by-passing the coils. Of course, forced-cooled units utilizing core form construction are entirely satisfactory if proper precautions are taken to direct the oil stream into the cooling ducts by means of baffles.

Earlier it was mentioned that completed coils are baked to cure the shellac or varnish used to bond the coils and insulation together. Before this is done, the entire coil stack with the insulating spacers is compressed in a hydraulic press by a force equal to that which would exist in the axial direction during a short circuit. Figure 8 shows a coil in the press. As the insulating spacers shrink under the pressure during the baking period, powerful springs arranged at the top of the coil stack prevent appreciable reduction in the amount of pressure being applied. The compressed dimension is maintained while the coil is placed on the core, and the clamping frame holds the coil to the prescribed dimensions thereafter. If a short circuit occurs in service, any additional compression of the coil due to the forces set up by the heavy short circuit current will be negligible, and no distortion of the wire or damage to the insulation will occur. We have been using this coil compressing method since the late 1930's, and it has proven to be completely effective. Of course, the core-and-coil clamping structure, which might be called the mechanical circuit, also must be designed to resist distortion in case of a short circuit. Figure 9 shows the massive construction required to support and clamp the core-and-coil assembly. The other major component of the mechanical circuit is the tank which encloses the core-and-coil assembly and forms the container for the insulating oil. Modern equipment for cutting and shaping steel plates and the advantages of welded construction make it possible to fabricate tanks best suited to the individual designs.

The transformer which suppiles power to an electric arc furnace is a specialized type of power transformer. Many of the design principles already discussed apply

Figure 8 — Coils are hydraulically compressed so that no movement can take place during a short circuit.

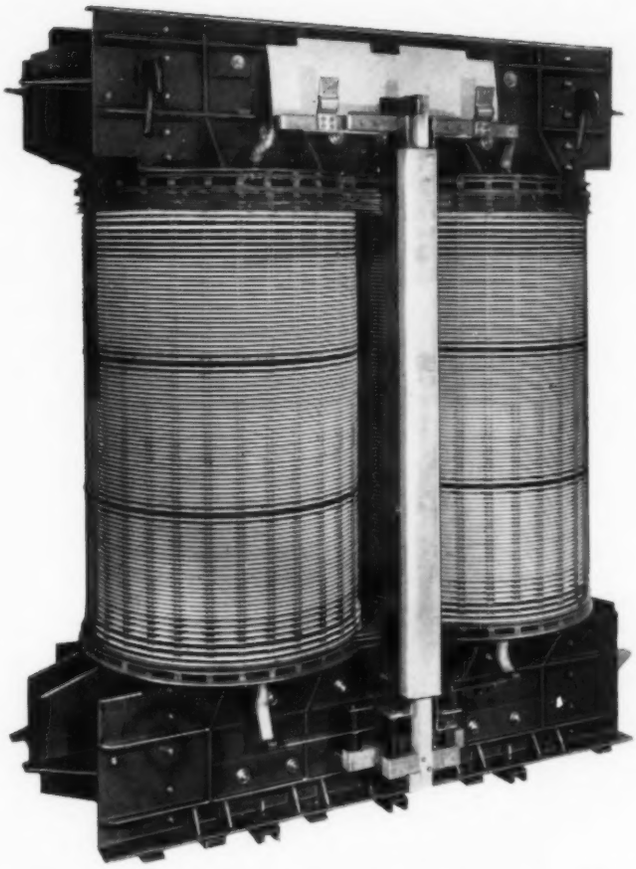


Figure 9 — Core-and-coil clamping structure provides a rigid support for the internal assembly during shipment and is designed to withstand forces of short circuit.

also to furnace units, but there are a number of additional problems due to the nature of the load. It has already been mentioned that the design of the electric circuit is complicated by the low voltage and high current required by the arc furnace. The recent trend has been toward higher secondary voltages in order to permit larger furnaces and increased efficiency. However, the secondary voltage rarely exceeds 450 volts, which is of course very low compared to conventional power transformer of equivalent size. Secondary currents in excess of 30,000 amperes are required in some cases where an extended full capacity tap range is used. These requirements of course mean very few effective turns—usually 2, 3 or 4—and an extremely large cross-sectional area for the secondary winding. This is usually accomplished by providing several sections, each with the required number of turns, and connecting them in parallel as shown in Figure 10. The low voltage coil is wound outside of the high voltage coil, and the leads are brought out radially. The leads from each section are brought out through the cover. The arrangement of the bars is designed to match the interleaved bus structure between the transformer and the furnace.

Frequently as many as six or seven low voltages are required at the full capacity of the unit and as many additional voltages at reduced capacity. With the construction of the low voltage winding, which has just been described, it is apparent that it would be impractical to provide these various low voltages by means of taps in the low voltage winding. Consequently, the magnetic circuit of the transformer is utilized to provide the tap range required. For any value of voltage applied to the primary winding, a "volts-per-turn" figure is established which is a measure of the number of lines of magnetic flux which will be established in the core. Since this core flux also links the turns of the secondary winding, the "volts-per-turn" figure is essentially the same for the secondary, and the voltage induced in it is determined by the number of turns. If the same primary voltage is applied to a larger number of primary turns, both the "volts-per-turn" and the induced secondary voltage will be lower. Thus, by providing an extension of the high voltage winding in several steps, the secondary voltage may be varied through the desired tap range. Additional tap voltages are obtainable by arranging the high voltage winding so it can be connected either in star or delta. The lower voltages obtained with the star connection are at a reduced capacity due to the current limit of the low voltage winding.

Figure 10 — Internal assembly of a furnace transformer, low voltage side (25,000 kva, three-phase; high voltage 13,800 volts, low voltage 430 to 290 volts).

With this understanding of the fact that the low voltage is varied by changing the number of turns in the high voltage winding, it is possible to examine a problem presented by the connection of several low voltage groups in parallel. Obviously the best conditions are obtained when each of the low voltage sections connected in parallel carried an equal portion of the current. One of the factors which influences the current division is the impedance between each low voltage section and the high voltage winding. The best possible condition is obtained when the impedance between each of the low voltage sections and the high voltage winding is equal. This condition should be met on all tap positions so that the best possible load division will be obtained regardless of the low voltage connection being used. In a shell form or an interleaved core form design, these requirements result in a rather

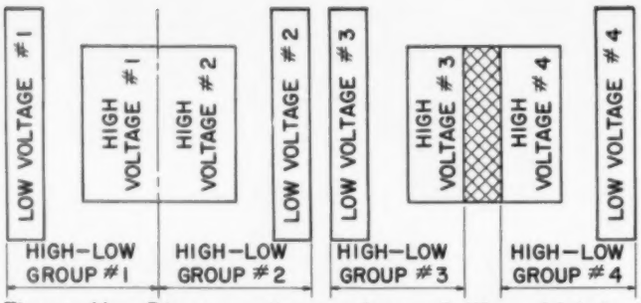


Figure 11 — Diagram of one phase of "four high-low group" design, shell form or interleaved core form with no taps.

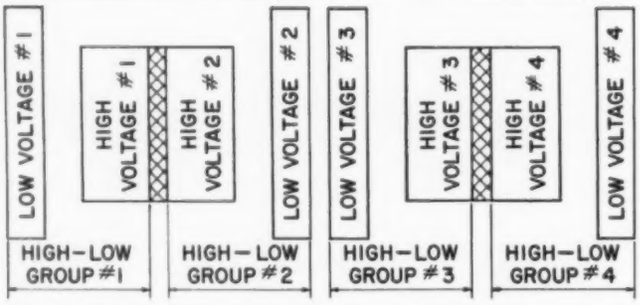


Figure 12 — Diagram of one phase of "four high-low group" design, shell form or interleaved core form with all taps at one point in high voltage winding.

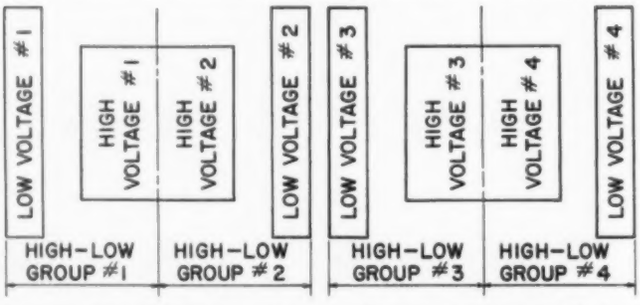


Figure 13 — Diagram of one phase of "four high-low group" design, shell form or interleaved core form, with taps at two points in high voltage winding.

complicated winding arrangement. With this type of design, the winding is said to consist of several "high-low groups," and there usually are as many of these groups as there are low voltage sections to be connected in parallel. Figure 11 shows a diagram of one phase of a "four high-low group" design with no taps. This diagram represents either a shell form or an interleaved core form unit. The impedance is calculated for each group, and if the four low voltage sections are to be paralleled, the impedance must be the same in each case. The impedance will depend upon the physical dimensions of the windings, the distance between the high and low, the number of turns, and the voltage and current of the windings. In this simple case, the high voltage windings could be connected either in series or in parallel. Figure 12 shows a case where a portion of the high voltage turns have been tapped out of the winding, as shown by the cross-hatched area. If this arrangement is used, the physical size of high voltage sections No. 3 and No. 4 will be reduced and they will include fewer turns. The impedance of sections 3 and 4 will be less than that of No. 1 and No. 2, with the result that they will assume more than their share of the load. These sections may then be overheated and the total loss of the transformer may be increased. One solution is to divide the tap section so that the effect of tapping out turns is the same for each "high-low group" as shown in Figure 13. In this case, however, if the high voltage groups are in series, two separate tap changes along with two sets of tap leads must be used, since the two tap groups are at different potentials. If the high voltage groups are paralleled, a single tap changer can be used, but the lead assembly is still quite complicated, and the high voltage winding current may not be suitable for subdividing. Of course the arrangement becomes even more complicated if the low voltage current is large enough to require more than four sections in parallel.

Another construction which avoids all of these complications of interleaved windings is shown in Figure 14. The core form construction is used with concentric cylindrical windings. Since the design is classified as a "one high-low group" type, the low voltage winding can be subdivided into as many sections as needed for the best winding and bus bar arrangement. The low voltage sections all have an equal number of turns. The

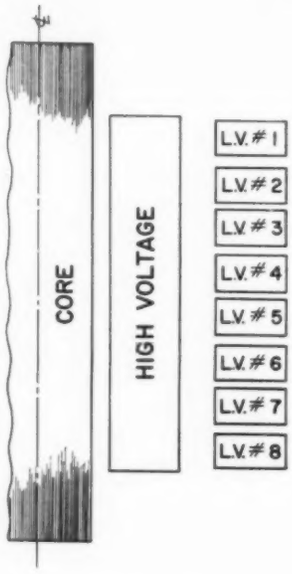


Figure 14 — Diagram of one phase of "one high-low group" design with concentric core form design.

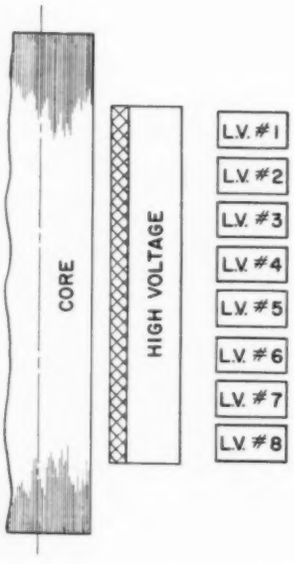


Figure 15 — Diagram of one phase of "one high-low group" design with concentric core form design with tap turns cut out at inside of high voltage winding.

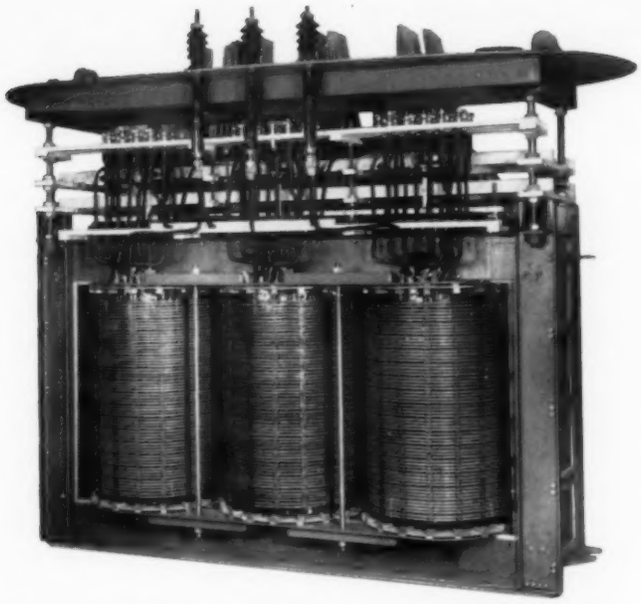


Figure 16 — High voltage side of a furnace transformer. Tap leads are brought to a terminal board; tap changer is motor driven (18,000 kva, three-phase; high voltage 13,200 volts, low voltage 375 volts).

same dimensions, and the same separation exists between the high voltage winding and each of the low voltage sections. The combined effect of the impedances between each of the low voltage sections and the high voltage winding, and the impedances between the various low voltage sections results in a satisfactory current division. The required tapped portion of the high voltage winding is provided at the start of the winding as shown in the cross-hatched area of Figure 15. Since only one "high-low group" is used, the impedance from the high voltage winding to each low voltage section is affected almost equally when taps are changed and the load division is still satisfactory. Complicated high voltage lead assemblies are avoided and a single set of tap leads per phase is sufficient. Control of the furnace electrode positions can be provided through current transformers connected in one of the low voltage sections of each phase.

Since it is a characteristic of an electric arc that the resistance will decrease as the current increases, the arc may become unstable unless sufficient reactance is provided in the circuit. For large installations, the inherent reactance of the transformer, along with that of the leads to the furnace, may be sufficient. For medium size units, it is frequently necessary to provide additional reactance in the form of an iron core reactor. This is normally mounted in the same tank as the transformer and a number of taps are brought to a terminal board so that the required connection can be selected by the operator. During the early portion of a melt, numerous short circuits occur as solid scrap falls against the electrodes, and the current which flows during these shorts is limited by the reactance of the circuit. To maintain the effectiveness in limiting the current during short circuits and in order to avoid saturation of the iron core of the reactor at higher currents, the reactor is designed to have low flux densities at normal load current. Usual practice is to provide a straight line reactance characteristic up to two or two-and-a-half times full load current.

Taps are usually changed several times during the progress of the melt as the power requirements change. Seven or eight tap leads are brought to a terminal board, as seen in Figure 16, and connections are made so that as many as six voltages are available by operating a motor-driven tap changer. Suitable interlocks are provided so that the circuit breaker must be opened before the tap changer is operated. The operations of the breaker cause voltage surges which may reach several times the operating voltage of the transformer. Although these voltages do not reach the magnitude of lightning surges on transmission lines, the condition is severe due to the frequency of the switching operations. Therefore, generous margins must be allowed in designing the dielectric circuit.

It has been mentioned earlier that the nature of furnace operation produces frequent short circuits during the early part of the melt. The forces produced in the transformer during these shorts are very large and a better understanding may be gained from a diagram. Figure 17 shows a section through the upper half of a concentric wound, core-form transformer. The current will flow in opposite directions in the high voltage and the low voltage windings, and the forces produced will tend to separate the two windings. These forces

Figure 17 — Diagram of upper half of one phase of "one high-low group" concentric core form design.

"A" = electrical center of upper half of high voltage winding.

"B" = electrical center of upper half of low voltage winding.

F_T = total short circuit force.

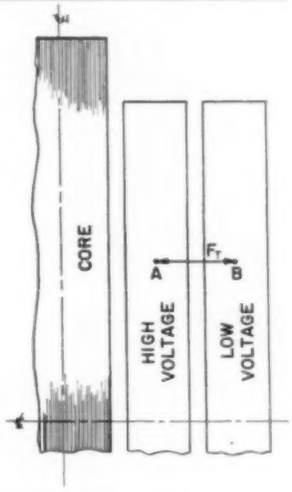


Figure 18 — Diagram of upper half of one phase of "one high-low group" concentric core form design.

"A" = electrical center of upper half of high voltage winding.

"B" = electrical center of upper half of low voltage winding.

F_T = total short circuit force.

F_R = radial component of F_T.

F_A = axial component of F_T.

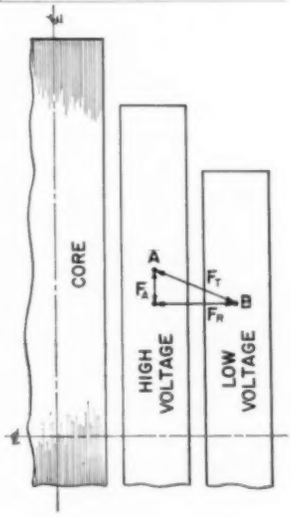


Figure 19 — Water-cooled furnace transformer frequently has cooling coils inside the tank.

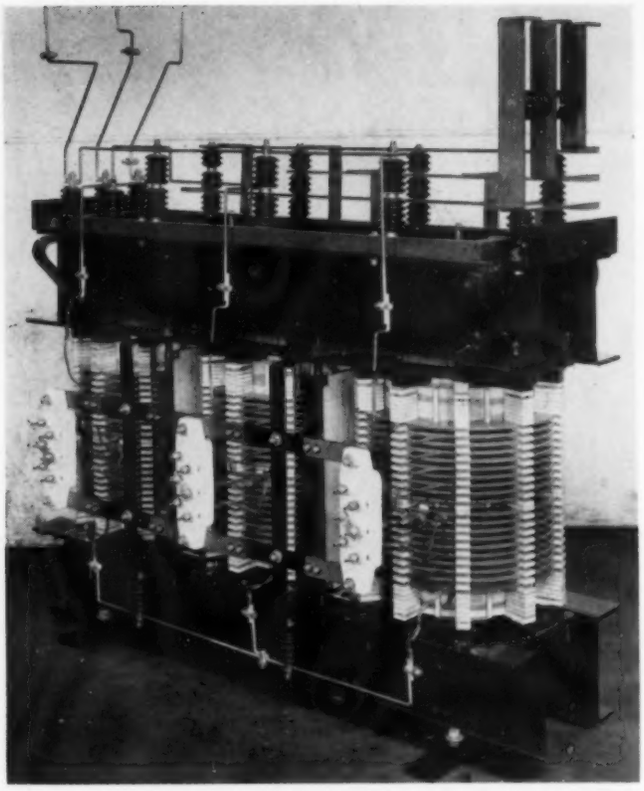


Figure 20 — Core-and-coil assembly for a typical dry type transformer (1000 kva, three-phase; Class H insulation; high voltage 12,470Y volts, low voltage 480 delta volts).

may be considered as acting between the electrical centers of each half of the two windings, and if the dimensions and turn distribution of the windings are such that the centers are in the same plane, the entire force will act in a radial direction. The force acting to collapse the inner high voltage winding is, of course, resisted by the strong insulating barrier around the core. Since the outer low voltage winding is circular, the entire bursting force on this winding acts against the tensile strength of the copper wire used in the coil. Proper selection of wire sizes will eliminate any chance of distortion of the winding during a short circuit. Figure 18 shows the diagram of the forces which would exist if the low voltage winding were considerably shorter than the high voltage. Here the total force still acts between the electrical centers, but it can be resolved into a radial force and an axial force. The axial component acts to elongate the high voltage winding and to compress the low voltage. The importance of a balanced design to minimize the axial component of the short circuit force is obvious. Practically, it is impossible to obtain a perfect balance for all tap positions. Therefore, a substantial clamping frame is provided at the ends of the winding to withstand the tendency of the longer winding to elongate. The precompression of the windings in a hydraulic press, which was mentioned in connection with power supply transformers, prevents any distortion of the windings due to the axial component of the short circuit force. It is interesting to note that with an interleaved design, the total short circuit force of the largest "high-low group" must be resisted by the coil clamping structure, since this force is at right angles to the plane of the coils.

The electrode holders of the arc furnace are usually water-cooled, and the water also can be used advantageously in the thermal circuit of furnace transformers. The most popular construction is the water-cooled type in which a cooling coil is placed inside the tank shell. Figure 19 shows a top view of a tank with the cooling coil in place. The coil is made of copper tubing and the circulation of water through it dissipates the heat produced by the losses in the core and coils. In some cases, the oil is pumped through an external water-cooled heat exchanger. The elimination of radiators around the tank, such as are used on self-cooled units, makes the transformer much more compact and a smaller vault may be used. Furthermore, if a self-cooled unit were used in a vault, it would be necessary to install a ventilating system for adequate circulation of air around the radiators.

The transformers used in load-center substations are usually moderate size units; a rating of 3000 kva, 3-phase is seldom exceeded. The design features which are most interesting concern the thermal and dielectric circuits. In order to be located most conveniently for serving specific machinery in the mill, the units must be designed for indoor installation. Due to the fire hazard, oil-filled units can only be used if expensive vaults are provided. A non-inflammable synthetic liquid known as askarel may be used instead of transformer oil for liquid-filled transformers; however, the use of certain compounds, such as varnish, must be avoided. Disadvantages of askarel are its high cost

TABLE I

Comparison of Characteristics of Liquid Filled and Dry Type Load Center Transformers — 15 Kv and Below — 1500 Kva and Below — Askarel Units Used as Base

Consideration	Liquid filled		Class "B" ventilated	Class "H" ventilated	Class "H" sealed
	Oil	Askarel			
Approximate price, per cent	80	100	100	100	120
Impulse strength, per cent	100	100	50	50	50
Total loss, 75 C, per cent	100	100	100	105	95
Total loss, 150 C, per cent	—	—	—	123	113
Weights, per cent	88	100	70	60	115
Average temperature rise (C)	55	55	80	150	150
Hot spot temperature rise (C)	65	65	110	180	180
Floor space, per cent	100	100	100	90	120
Height, per cent	100	100	95	95	110
Location	Outdoor	All	Indoor	Indoor	All
Fire, explosion and toxic resistant	No	No	No	Yes	Yes
Liquid Maintenance	Yes	Yes	No	No	No
Internal cleaning	No	No	Yes	Occasionally	No
External cleaning	Normal	Normal	Occasionally	Occasionally	Minimum

and the fact that toxic vapors will be produced in case of arcing within the unit.

For these reasons, "dry type" transformers are becoming very popular for this type of application. Figure 20 shows a typical core-and-coil assembly for one of these units which may utilize either Class "B" or Class "H" insulation. Class "B" insulation includes mica, asbestos, fiberglass, and similar inorganic materials in built-up form, with organic binding substances. It is suitable for use with an average winding temperature rise of 80 C. Class "H" insulation consists of the same inorganic materials, with binding substances composed of silicone compounds or materials with equivalent properties. It is suitable for an average temperature rise of 150 C. These higher permissible temperatures are possible because they will not decrease the life of this type of insulation. The higher temperature limits make the dry type units practical since the cooling is less effective than with oil-filled transformers. Cooling ducts are generally larger than those used for oil-filled units, and with the ventilated type of construction, generous openings are provided in the case which encloses the unit. The ideal construction for contaminated areas is the sealed Class "H" unit, which has a completely sealed tank filled with nitrogen at a few pounds pressure.

Table I compares a number of characteristics of liquid-filled and dry type transformers. The data is typical of units rated 1500 kva or less with high voltage windings in the 15-kv class or below. The oil-filled unit is naturally less expensive, since the oil is much cheaper than askarel, and the cooling is more effective than with the dry types. The higher price of the sealed Class "H" unit reflects the fact that the windings must be designed for a lower gradient over the surrounding atmosphere, since the temperature rise of the gas in the sealed unit will be considerably higher than that of the air circulating through the ventilated unit. Also, the tank construction is somewhat more expensive in order to contain the nitrogen gas under pressure. The lower impulse strength of the dry type units presents no problem if the distribution system is adequately protected against lightning surges. The lower loss of the sealed unit at 75 C reflects the lower current densities in the windings required by the lower gradients. Losses for Class "H" units at 150 C are, of course, higher due to the increased resistance of the windings at the higher temperature.

The larger dimensions required for the sealed Class "H" unit are due to the greater tank surface needed, since this is the only cooling surface exposed to the ambient. The safety features and minimum maintenance requirements of Class "H" units are self-explanatory, with the sealed unit offering the ultimate advantage in a contaminated atmosphere. Since the atmosphere is excluded from the windings, no clogging of cooling ducts can occur, and the non-oxidizing atmosphere assures a longer insulation life. Some temperature advantage is obtained from the nitrogen atmosphere, but loss of the nitrogen in the event of a leak will not result in dangerous temperatures or excessive loss of insulation life.

This paper has presented some of the most important problems encountered by the transformer designer, and, has discussed the most effective methods of solving these problems. Unfortunately, such desirable features as low losses, large insulation safety factors, low temperature rise, and mechanical stability are obtainable only at the expense of increased transformer size, weight and cost. Therefore, careful analysis of the problems is necessary so that maximum economy is obtained without sacrificing performance or reliability.

BIBLIOGRAPHY

1. "*Power Co. Service to Arc Furnaces*," by L. W. Clark, AIEE Proceedings, Nov. 1935.

2. "*Fundamental Considerations in Supplying Power to Arc Furnaces*," by F. M. Starr and O. B. Falls, 1941 Proceedings AISE.

3. "*Performance and Power Supply of Large Electric Arc Furnaces*," by B. M. Jones and Stearns, AIEE Proceedings, 1941.

4. "*Progress in Supplying Power to Arc Furnaces*," by C. C. Levy, 1944 Proceedings AISE.

5. "*The Electric Furnace West of the Rockies*," by W. B. Wallis, 1954 Proceedings AISE.

6. "*Trends in Electric Arc Furnace Practice*," by D. L. Clark and J. A. Clark, 1950 Proceedings AISE.

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COLD ROLL FORMING

. . . . an expanding field for cold rolled forming is seen for the future . . . . when product engineers are aware of the possibility of this method, it is believed that this industry will be able to absorb a large percentage of the increased output of steel mills . . . .

▲ TO those already in cold roll forming field, it seems strange that so many are entirely unacquainted with this method of forming metal. It is not a new process, but can be traced back forty to fifty years. Because it is primarily a process for large volume production, its use did not become widespread until the demand for automobiles became so great that better and faster methods of producing sheet metal parts were needed. Cold roll forming offered to the automotive industry an extremely fast method of forming these parts to the very close tolerance necessary for mass production and interchangeability.

Cold roll forming is a process of forming metal from sheet, strips or coiled stock, into shapes of uniform cross-section, by feeding the stock longitudinally through successive pairs of rolls, each pair of rolls progressively forming the stock until the finished cross-section is produced. The parts so produced are uniform in cross-section and dimensionally held within very close tolerances. These tolerances depend, of course, somewhat on the gage tolerances on the material being formed, but may be as close as $\pm .002$ in. on small shapes formed from light gage material.

Because cold roll forming has satisfied the need for equipment to produce economically and quickly, uniformly accurate parts, its use has spread until today it is being used wherever metal is processed into shapes of uniform cross-section.

All fields of transportation make use of the process in the manufacture of their equipment. In the automotive industry, gas lines, headlamp rims, window channels, trim shapes, scuff plates, truck body panels, trailer flooring, frames, siding, steering columns, axle housings, radiator tube, and many other parts are cold roll formed. In aircraft, the frame work, trim and even parts for jet engines are made by this method. Bicycle wheels, frames, handlebars and fenders are made in this equipment as are parts for baby buggies, toys, wheelchairs and most any other rolling equipment. Fireproof partitions and doors in ocean boats, stainless steel sides on passenger trains, frames for diesel locomotives and freight cars are now being produced at high rates of production on cold roll forming equipment. In the building construction field, cold roll formed metal parts are rapidly replacing wood in both residential and commercial building construction. In homes, steel windows and doors, complete with their frames are now being obtained. Down spout, eaves trough, corner bead, have for a long time, been made by this process. Parts for commercial buildings such as warehouses, quonset buildings and farm buildings are almost completely manufactured, ready for assembly, on cold roll forming equipment. Metal store fronts and complete metal facings for large buildings are now being made by this process.

Cold roll forming machinery is built in a range of sizes to form material from several thousandths of an inch in thickness, up to one-half inch thick. This material varies in hardness from dead soft up to the high strength steels used for structural purposes. To form this range of material, machines have been designed

Figure 1 — This typical overhung spindle cold roll forming machine with capacity for forming up to 3 in. wide x 0.060 in. thick mild steel is used for forming moldings, decorative trim shapes, and weatherstrip.

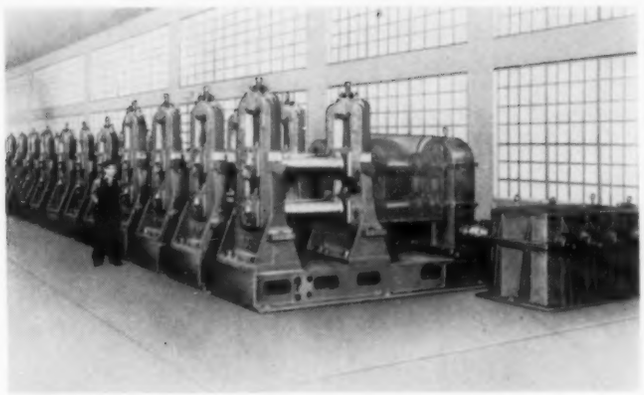


Figure 2 — Mill type cold roll forming machine shown is used for forming heavy structural shapes up to 18 in. wide x ½ in. thick high strength steel.

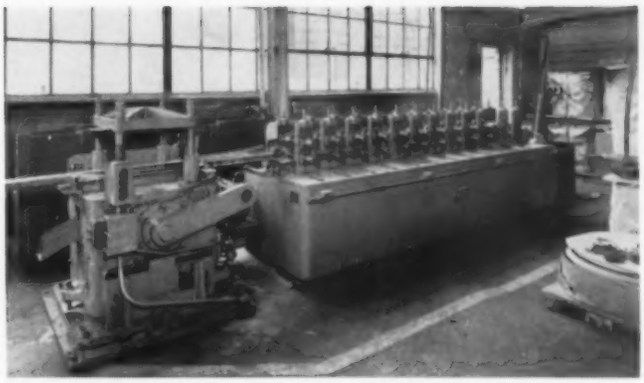


Figure 3 — This type of cold roll forming machine is commonly used and is built with width capacities up to 60 in. and gage capacities up to 0.156 in.

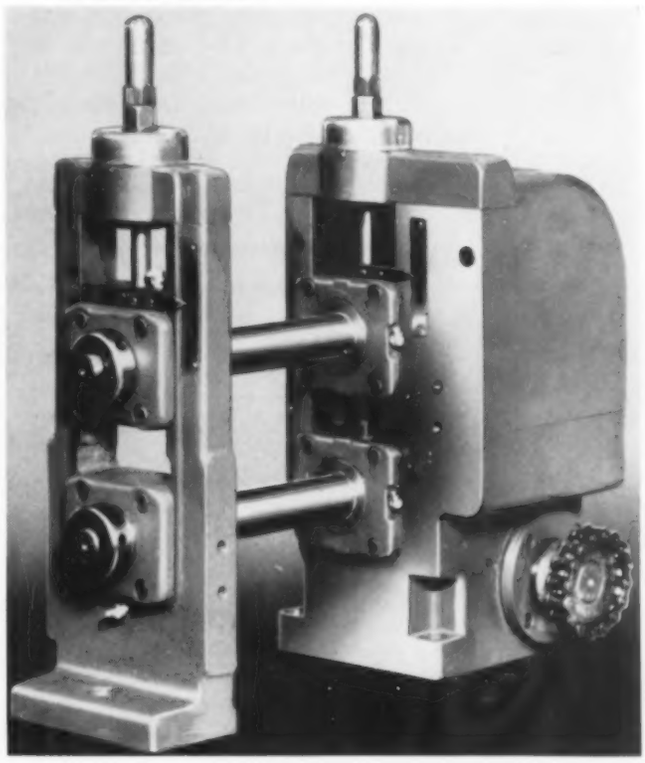
with roll spindle diameters from one to 15 in. in diameter, with roll passes numbering from two up to thirty or more. They form products from the miniature or toy railroad track made from 0.005 to 0.010-in. tin plate up to 26-in. diameter ½-in. wall pipe. Figure 1 shows a roll forming machine with overhung roll spindles, suitable for forming light gage small shapes. Figure 2 illustrates a large mill type machine capable of forming heavy structural shapes from ½-in. plate. The design of these mill type machines is such that the roll spindles are removed from the mill to make a roll change, whereas in the small and medium size machines the rolls are removed for changing without removing the spindles from the machine. This type of machine is built in size ranges from 3½-in. diameter roll spindles up to 15-in. diameter roll spindles.

Between these two ranges and illustrated in Figure 3 is the type of roll forming machine most popular and most universally in use today. It is built in sizes ranging from 1½-in. diameter roll spindles up to 3½-in. diameter roll spindles. The length of the roll spindles, or the width capacities of this type of machine can be varied to suit any practical width of material by providing larger spindles and a wider base plate. The unit construction permits flexibility in the number of spindles or roll passes. The machines can be provided with a small number of spindle units, but with base plate capacity for a much greater number, thus providing for future needs. Figure 4 shows the general construction of the unit for this type of machine. Figure 5 is a rear view of this type of machine with one of the housing covers removed to show the gearing arrangement. The drive is direct from a high torque motor or variable speed unit through "V" belts or chain to the worm shafts of the units. The worm shafts of the individual units are coupled through chain type couplings. The bottom spindle is driven direct from a worm gear. The top spindle is driven through a toggle gearing arrangement which permits considerable vertical adjustment of the top spindle without disengaging the gears from their proper mesh. The roll diameter can then vary to accommodate various depths of shapes and, when rolls are properly designed, they can be redressed many times to smaller diameters, extending their useful life indefinitely. For convenience in mounting rolls and making adjustments, the machines are equipped with micrometer dials on the top spindle adjustment.

Although manufacturers of roll forming equipment vary the designs in detail, it is general practice to build these machines with variable vertical center distance on the spindles, unit construction of the driving heads and base design which can easily be adapted to variations in number of spindles and also length of spindles.

Because automation today is becoming more and more necessary to produce parts more economically and more accurately, roll forming equipment is being combined with other equipment to completely manufacture parts with a minimum of handling. Most important and most commonly used is some type of flying cutoff machine to cut off the shape after it is formed in the roll forming machines. This is necessary because material for roll forming is furnished mostly in coils and the product is generally a straight piece from

Figure 4 — Single unit shown is used in building up a standard roll forming machine. These units are built with spindle diameters up to 3½ in., and spindle lengths up to 60 in.



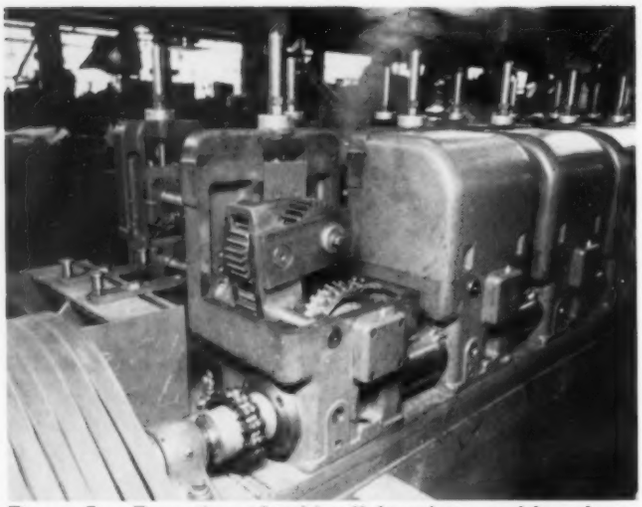


Figure 5 — Rear view of cold roll forming machine shows drive and gear arrangement.

several inches to many feet in length. Figure 3 shows a four post press type flying shear used at the exit end of a roll forming machine into which coil stock is being fed. In this type of cutoff machine, the formed shape passes through the open die until the end of the piece strikes a target which trips the press. As the cut is being made, the die is carried along the die table on slides by the shape until the cut is completed.

Then springs return the die to its original position ready for another cycle. The target is adjustably mounted along a runout table to vary the length of the finished pieces. This type of cutoff machine maintains uniform lengths of cuts to a very close tolerance ($\pm\frac{1}{64}$ in.). Another style, designed for cutting shapes which lack column strength for pushing the die while the cut is being made, is equipped with a power driven die table. Still another type uses a saw instead of a die for cutting shapes that are liable to collapse if cut with a die. These flying shear type of cutoff machines are frequently installed at both the entrance and exit ends of the roll forming machine. The first cutoff then prenotches the flat strip to partially make the cut. After passing through the roll forming machine to be formed, the second machine, indexing from the notch, completes the cut to produce a shape of cut end not possible with one die.

Rings such as bicycle rims, headlamp rims and curved parts can be formed and coiled in the roll forming machines and cut off into individual rings in special flying shear type cutoff machines. Polishing units, printing and embossing rolls, piercing rolls, slitting rolls, are combined with roll forming in unique applications. Combined with various types of gas and electric welding equipment, welded tubing and pipe is being produced by cold roll forming at speeds up to 200 fpm, and in sizes from ¼-in. diameter up to 26-in. in diameter. Such a combination of machines is shown in Figure 6.

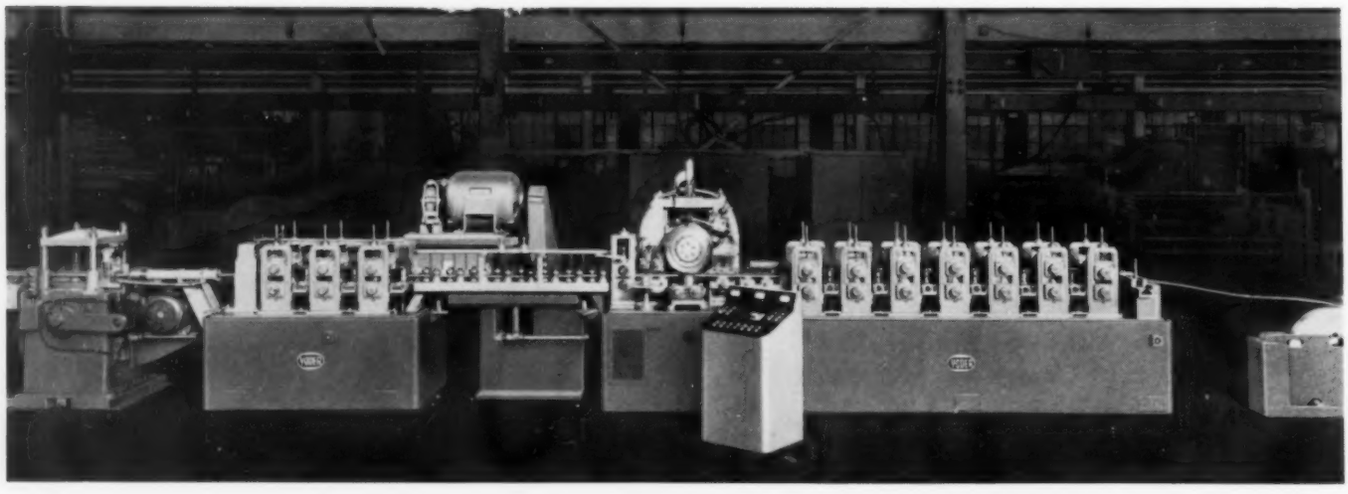
To further increase production and efficiency of cold roll forming equipment, supplementary equipment is often used. Where maximum production is of extreme importance, butt welders combined with looping arrangements are used. By unwinding into a loop, the trailing end of a coil of material already partially formed and being passed through the forming machine, is butt welded to the starting end of a new coil of material without stopping production, thus making a continuous, uninterrupted flow of material through the machines possible.

Where volume production warrants it, slitting equipment is of economical importance in supplying the proper width of stock to the machines. It enables the manufacturer of roll-formed products to order and carry in stock, only wide coils of material, slitting it to the proper width when needed.

The rolls for forming shapes are generally supplied by the manufacturer of the machines, but can be made in any well equipped tool room by some one experienced in the design and manufacture of rolls. There are several methods of designing and making rolls, the choice of methods used depends on the knowledge, skill and machinery available. It is not the intention to discuss here in detail, the design and manufacture of these rolls, but only to give the reader a general idea as to the procedure used in the several methods.

The most important and also the most difficult part in all methods is the planning of the progressive shaping of the material which determines the number of roll passes necessary to form a shape. Not being an exact science, it requires experience, good judgment and some knowledge of the bending of metals. The

Figure 6 — Roll forming is combined with welding and cutting operation in a resistance weld tube mill.



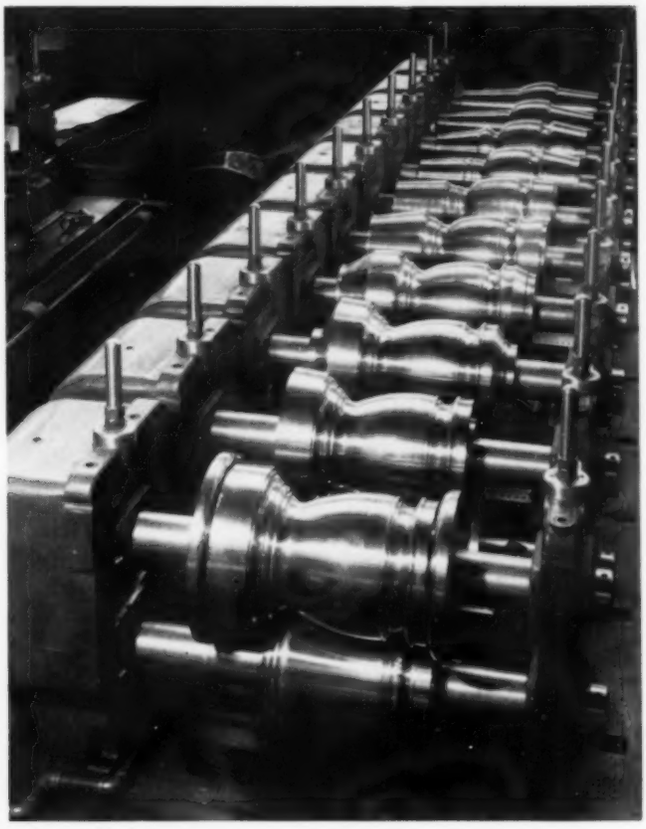


Figure 7 — A complete set of rolls, mounted on a roll forming machine, shows the progressive stages necessary for forming a shape from sheet metal.

forming progresses from the middle of the sheet outwardly, to the edges, and generally the edges are formed upwardly. Figure 7 is a view of a complete set of rolls mounted in a machine, and shows the progressive steps in the forming of a shape, the pair of rolls at the bottom of the photograph producing the finished shape or cross-section. Once the plan for producing the shape and the number of roll passes has been established, the rolls are designed and made either from roll drawings which have been very carefully and completely dimensioned or from templates. If drawings are used in preference to templates, they must be prepared by a draftsman skilled in the use of trigonometry to the extent that each change in contour on the roll must be dimensioned both for diameter and length.

The rolls are then manufactured from these drawings without the use of templates. If templates are used for manufacture of the rolls, they are prepared either from multiple size layouts and reduced on a pantograph type machine; or made to exact size directly by a skilled template maker. In machining the rolls it is obvious that because of the number of steps involved in the design and manufacture, in each of the steps accuracy must be held in order that accumulated errors will not result in an unsatisfactory product.

Rolls are made from a number of different materials, depending on their use, taking into consideration the fact first that a large part of the cost of these forming rolls is in the design, manufacture and development of the rolls to produce a satisfactory product. Thus the difference in cost of the roll material does not represent the actual difference in cost of the rolls made from them. Although not commonly considered for roll material, treated wood and resin impregnated materials have been used for rolls for forming simple shapes of light gage material for short production runs.

The advantage gained in using them is mainly in the time saved in getting into production. Wood rolls are known to have produced as much as a quarter million feet without replacement. Most commonly used is a medium priced oil hardening tool steel, hardened to 60-63 Rockwell "C." When roll forming unpickled hot rolled steel, high carbon—high chrome roll material is used because of its resistance to abrasion.

Cast iron and soft machine steel are used for spacer rolls and for forming light gage shapes. Contours and bores of rolls are generally ground after hardening to assure concentricity. The pairs of rolls are always checked and matched for proper clearances before mounting on the machine.

The ground finish is generally suitable for forming hot or cold rolled steel sheets, but highly polished rolls are necessary for forming stainless steel and enameled or coated stock. Chrome plated rolls are often furnished for forming highly polished or coated material. Rolls are generally made in sections for convenience in machining, handling when mounting on the machine, and replacing of worn sections.

The life of a set of rolls depends on the type of material being formed, the gage and shape being formed, and the care which is given them. Rarely is a complete set of rolls replaced due to wear. If parts of rolls subject to wear are replaced when worn, and before extra work is placed on succeding roll passes, the set of rolls will last indefinitely.

With machines designed to accommodate varying roll diameters, the complete sets of rolls can be redressed a number of times, reducing the diameters each time, but maintaining the contours of the rolls to produce a shape within the required tolerance. Rolls have produced up to five million feet without redressing and up to fifty million feet or more when properly redressed and maintained. Modern roll forming machines are all provided with roll lubricating systems which add greatly to the life of the rolls and help to produce a better product.

The materials from which roll formed products are made include practically any metal, ductile enough to form without appreciable thinning of the gage of the stock. It is furnished generally in coils, in which case it is fed into the forming equipment from coil boxes or reels, and is cut off after forming, with an automatic cutoff machine. Some material such as thin gage wide sheets are often furnished cut to length and fed from roller type tables into the forming line. Intricately shaped and pierced blanks are also readily formed by this process, although care must be exercised in this case to prevent distortion of pierced parts.

About ninety-eight per cent of all material used for roll formed products is slit edge material, the rest being mill edge stock. Mill edge material is difficult to obtain in the varied gages and widths demanded by the cold

roll forming industry. The width tolerances are not always close enough to suit the tolerances on the product. One possible objection to using slit edge stock is the burr or raw edge on the finished product. Although it is not practical to completely round the edges in the roll forming process, it is possible to condition them enough so they are not a hazard in handling the finished product. Today most of the large manufacturers of roll formed products have their own slitting equipment. They purchase all gages in wide coils and slit to suit their needs.

Practically all types of finished surfaces are readily roll formed without injury to the surface. Hot rolled unpickled steel is often formed today with only a decreased roll life and a cleaning problem on the equipment a necessary consideration. The very highly finished stainless steel requires only polished rolls, careful lubrication and care in handling. Galvanized, plated or treated surfaces are not injured in the process. Pebbled and embossed materials are successfully formed as are the new prepainted and plastic coated materials.

Although generally thought of as a process strictly for forming or bending metal without changing the thickness or removing material, coining, embossing, piercing and slitting can be done. Sharp edges of slit material can be rolled to make rounded edges. On ornamental shapes where the corners on the outside of a bend are required to be sharp, the corners can be coined to appear sharp. Intricate designs can be embossed or impressed into the metal with engraved rolls. Piercing of a continuous row of holes can be accomplished with special piercing rolls.

Looking into the future of this industry signs of an expanding field can already be seen. Metal is being used in increasing amounts for the outside of buildings. Recently in New York prefabricated metal panels were installed in several days time over the entire outside of a new office building. New office buildings in Pittsburgh also show the trend toward the use of metal in new building construction, with very pleasing decorative effects. It is conceivable that sometime in the future, roll forming machines could be made portable, making it possible to roll form shapes to extend the entire length or height of a building, eliminating any cross joints, similar to what is being done today on the entire length of an 80-ft Pullman car.

Another field only slightly explored is the roll forming of structural shapes from plate instead of the hot roll shapes being used today. Shapes thus formed are exceptionally well adapted for use in welded construction as the rounded corners at the bends and the square edges present good conditions for welded joints. Small structural shapes such as the very popular 1 x 1 x $\frac{1}{8}$-in. angle can be more economically made from flat strips than by hot rolling as various gages of material and edge dimensions can be produced on the same set of rolls. On these light wall shapes, enough coining can be done in the roll forming process to produce round corners at the edges, and also sharper corners at the outside of the bends. With product engineers aware of the possibilities of cold roll forming, this industry can absorb a large percentage of the increased outputs of the steel mills.

DISCUSSION

PRESENTED BY

M. W. METSCHL, Specialty Product Shop Engineer, Lackawanna Plant, Bethlehem Steel Co., Lackawanna, N. Y.

ELMER J. VANDERPLOEG, Chief Engineer, The Yoder Co., Cleveland, Ohio

M. W. Metschl: In reading over this interesting paper on cold roll forming, we note the remarks relative to a large mill-type machine for forming heavy plate $\frac{1}{2}$ in. thick and those on forming structural shapes from plate instead of by hot rolling. It has been our experience that there is a growing demand for cold-formed shapes in somewhat lighter sizes, from $\frac{3}{16}$ to $\frac{1}{4}$ in. One class of manufacturers has developed a compound cold-formed section which replaces three small hot-rolled shapes, previously riveted together. Highway guard rails in 10 and 12 gage are being roll formed. The dump truck and trailer industry use cold-formed butted rectangular tubing in $\frac{3}{16}$ to $\frac{1}{4}$ in. gage and in sizes ranging from 4 x 2 in. to 6 x 3 in., and the building industry is using a special sheet steel corrugated filing in $\frac{5}{32}$- in. gage.

As the demand for the shapes is in small rather than large tonnages, and the shapes are varied and numerous, we have built a sort of universal cold-forming mill with a wide range of vertical center distance and adjustable longitudinal centers between spindles to accommodate the roll sizes and other conditions imposed to produce such a variety of sections on one machine.

Although the individual tonnages may be small, the sum total tonnage of a number of shapes can be considerable, thus permitting nearly full time operation of this one machine.

In order to build such a machine with the above characteristics it was necessary to depart somewhat from the conventional machine with line shaft and geared roll spindles. We decided on a complete electrical drive—namely a d-c motor generator set supplying power to individual d-c motors, rheostat controlled, driving each roll unit. This permits adjustment of roll speed as may be governed by a particular section due to shape or gage, and, if necessary, between some sets of rolls themselves.

The machine consists essentially of a long bed, provided with two longitudinal rails on which are mounted the required number of roll units. Each roll unit is an assembly of fixed stand and one outboard stand, mounted on a base, together with a lower and upper roll spindle. The lower spindle is driven only, through a d-c motor, rheostatically controlled, a herringbone reduction gear unit and necessary coupling.

The upper spindle is mounted in vertically adjusted boxes. Both roll spindles are mounted on antifriction bearings. The upper spindle has no direct drive and idles, getting its motion from pinch on the stock in the roll pass. By this method, upper rolls can be made

whatever size is required for a formed section, and vertical centers between rolls are limited only by range of the roll stands. This arrangement of idling upper roll tends to eliminate any speed differential between the two rolls in a pass.

Due to shape of a particular section, it may be desirable to increase the longitudinal centers of roll stands. This is accomplished by setting the roll unit where desired on rails of bed. Or, it may be necessary to remove a roll unit from bed to provide necessary space for side rolls or other guides between roll stands. The outboard roll stand can be adjusted in or out on roll unit to eliminate any unnecessary distance between stands, and thus overcome any tendency of roll spindle to spring.

The roll units can also be adjusted back and forth in relation to one another, thus permitting a certain amount of horizontal straightening if necessary.

This type of machine also permits removing a roll unit with its individual motor drive, and setting elsewhere in shop, and if fitted with proper attachments, can be used for curving sections or doing other shop work.

The maximum width of material this particular machine will handle is 24 in., in ¼ in. thickness—structural grade. Also 3/16-in. gage and lighter are rolled from strip in coils. Above 3/16 to ¼ in. thickness material is in long plate form. The cold-formed material is furnished in lengths ranging from approximately 10 ft-0 in. to 60 ft-0 in.

The remaining equipment consists of a power-driven let-off coil box, a power-driven roll straightener to straighten coils or plates before entry into pinch rolls, a power-driven six-spindle straightener for the formed section, and a power-driven friction saw. When rolling plate, a long power-driven roller table is set ahead of machine.

All formed sections run out on a long roller runout table approximately 180 ft long. As the rolled section approaches the end of this table, it strikes an electric tripper, which automatically stops the rolling machine. The long rolled section is then cut with a friction saw at the end of the machine, and pushed over on to another long roller table adjacent to a runout table by a power pusher. This operation is push-button controlled by the saw operator. The long rolled section is now pushed by power driven rolls into a cut-off die mounted in a power press, equipped with an adjustable gage table. Here the rolled section is cut into desired lengths. Experience has shown that most rolled sections can be cut with properly designed cut-off dies.

After cutting, the material is properly prepared for shipment.

This machine, as mentioned before, is very well suited for small tonnage rolling of a variety of cold-formed shapes. Rolls are made in sections, and in most cases can be manually mounted on roll spindles, permitting fairly rapid change-over for different sections. Rolls are made from moly steel forge blanks, properly hardened and ground where necessary.

Elmer J. Vanderploeg: Commenting on Mr. Metschl's description of a machine they have in their plant, which they designed themselves to suit their needs, that is a machine that is very flexible, very well suited to the kind of work that is being done. It is a jobbing shop machine.

There are times when a machine is going to be set up for a specific purpose, and that is all. For example, in the refrigerator industry, outer shell is made on a roll forming machine. That is a special machine designed for one purpose. It does not need the flexibility that Mr. Metschl is talking about.

The choice of type of machine can only be determined by carefully studying the requirements; both the immediate needs, and the possibilities for future use for manufacturing different products.

ELECTRIC FURNACE PLANT SOLVES FURNACE PROBLEM

▲ VOLTAGE flicker caused by fluctuating loads while a furnace is in the melting stage, was solved by the use of protective measures at the furnace bus of a steel company in Detroit, three Detroit Edison Co. engineers said in a paper presented at a System Engineering symposium at the fall general meeting of the American Institute of Electrical Engineers in the Morrison Hotel. The engineers were S. W. Luther, J. D. Ghesquiere and C. E. Quick.

Faced with the problem of supplying power for two new electric furnaces in a steel mill that produces hot and cold rolled steel, the engineers had the choice of several methods of preventing voltage fluctuation that would be annoying to other utility customers. The furnaces were 24 ft in diameter, 150 to 200 tons, supplied by a 25,000-kva transformer, with a maximum secondary voltage of 510 volts. Data were not available on a system of this magnitude and it was necessary to work out calculations based on 16,000-kva, 300-volt installations. After considering three methods, it was decided to supply the new furnace load from the utility system without change and to install corrective measures at the 24-kv bus supplying the steel load. These included adequate reactive generation, utilizing synchronous condensers near the load to shunt a sufficient portion of the furnace load swings from the remainder of the system.

Decision was made to install relatively low reactance machines and to also install reactors in series with the 120-24 kv transformers, thereby forcing the condensers to supply the required amount of the fluctuating load. Stability studies were made using various combinations of condensers and reactors. These studies indicated that two 50-mva, forty-five per cent reactance condensers with 75-mva reactors of eighty per cent reactance would be unstable. Decision was finally made to install two 50-mva, thirty per cent transient reactance condensers with 75-mva, fifty per cent reactors in the feeds. This combination is well within the safe margin of stability and was the most desirable combination when costs, delivery, performance, flexibility, and existing station installations were considered.

Antidotes for Sleeve Bearing Failures

By ANTHONY F. KAMINSKAS

Product and Field Engineer, Cleveland Graphite Bronze Co., Division of Clevite Corp., Cleveland, Ohio

. . . . most bearing failures are due to one or both of two causes, improper design and improper maintenance . . . . actual failures can be more specifically attributed to insufficient clearance, poor alinement, dirt, overloading and high temperature . . . .

▲ A psychologist will say that machines may be complex but never emotional and that one can drive a car but that one must manage people. However, a psychologist is not an engineer. Engineers know that machines can be temperamental and that a managed machine will perform better than a driven one. We, in the bearing business, can take a leaf from the psychologist's book however, for we have learned that the "proper approach" will make an engine with a "bearing breakdown" tell what initiated or motivated the failure, thereby being able to apply the proper antidote.

Knowing that sleeve bearings perform under conditions ranging from splash or grease fed to high pressure fed lubricated bearings, from slow speeds to 50,000 rpm, from no filtering to full flow filtering, under varying temperatures, through the art of extrapolation, one will find that many of the following comments can be applied to most sleeve bearing applications.

What are the logical steps that should be taken in a complete search for a solution to poor bearing performance? Although it has been known that sleeve bearings have been used for hundreds of years, it has not been until recently that the design engineer has availed himself of the information, which is perhaps at times camouflaged but available, through a thorough analysis of a sleeve bearing failure. It would be foolish to attempt to outline a firm flow chart which could be followed in analyzing sleeve bearing failures, especially since one failure may differ from the next by varying degrees. However, since each failure possesses a story of its own, the best approach to investigate a failure is on an individual basis. Keeping in mind that bearing trouble may be an indication of trouble elsewhere.

BEARING CONSTRUCTION

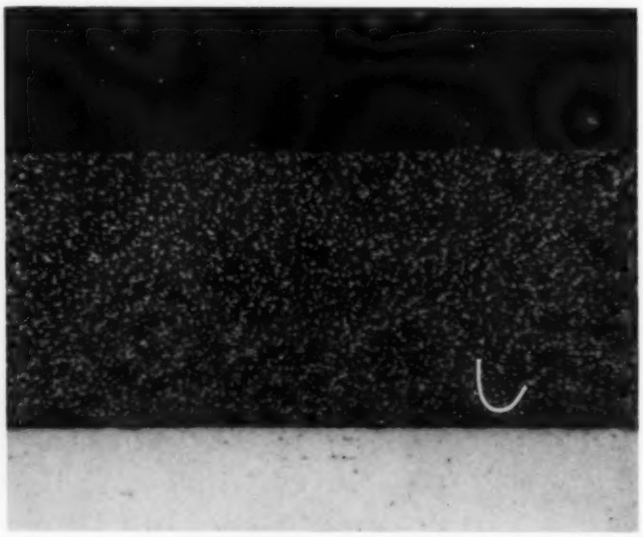
Before discussing some of the typical sleeve bearing failures, let us review briefly the most common types of bearing materials and constructions now in use.

Basically, there are three ranges of load service combinations that must be met by bearings serving automotive and diesel engines today. There are several variations in materials available to satisfy these combinations, and in many cases there is an overlap, depending on the circumstances, but essentially, the three most common types in use are:

1. Conventional thickness of babbitt on steel back for low loads.
2. Thin babbitt of 0.002/0.007 on steel back for intermediate loads.
3. Trimetal construction of steel back, copper-lead intermediate layer and thin babbitt surface layer for heavy loads.

Figure 1 illustrates the conventional tin or lead-base babbitt bearing of approximately 0.020 in. nominal babbitt thickness on steel which is considered to be the best bearing materials within its range of load

Figure 1 — Conventional babbitt bearings normally have about 0.020-in. babbitt thickness on steel.



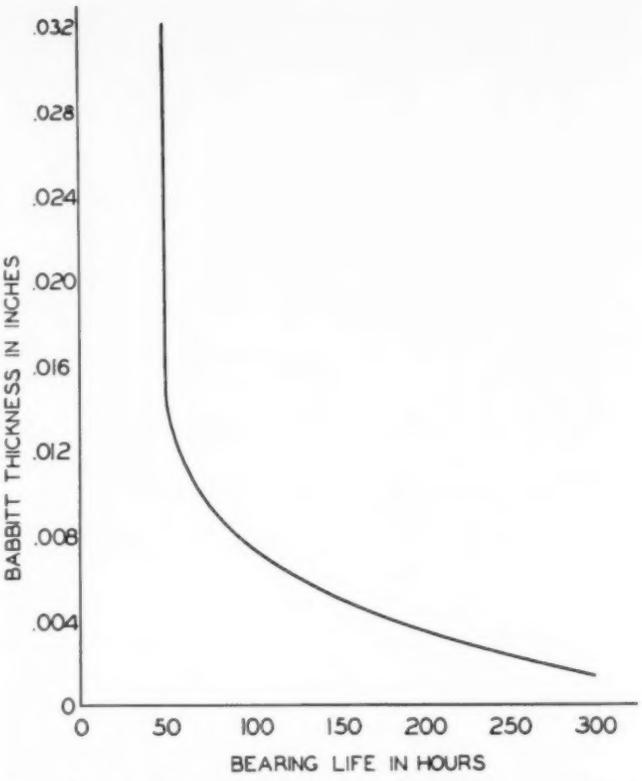


Figure 2 — Bearing life goes up as babbitt thickness goes down. Curve is given for a maximum unit load of 1330 psi.

carrying capacity. It has low inherent friction, a high degree of embeddability, and a low rate of wear between it and well finished journals. The relatively soft lining material in this type of bearing also makes it readily adaptable to engine off conditions, such as slight shaft misalinement, conformability to poorly machined surfaces, and is able to tolerate the presence of an unusual amount of dirt or other foreign material.

Figure 2 is a classical figure which illustrates the variation in bearing life with change in babbitt lining thickness on a steel back. Notice the distinct region at which longer bearing life takes place with decrease in babbitt lining thickness. Lining thickness held in the range of 0.002 to 0.005 in. is typical of the construction of the thin babbitt bearing.

The majority of the excellent characteristics of the conventional thickness babbitt bearing have been retained by this construction, with a possible 50 per cent increase in fatigue life. A recent development in manufacturing practice has permitted closer controls on lining thickness limits which made possible the manufacture of bearings to a smaller tolerance in thickness than previously. In many cases this has solved price problems in given applications which previously would have required the more expensive heavy duty bearing construction.

Another bearing construction consists of a strip cast copper-lead intermediate layer on steel back with an 0.001-in. precision plated overlay. There are several variations of method of preparing the intermediate layer in industry. One of its principal advantages is that the vertical grain structure retains a better degree of embeddability than the horizontal or spherical grain structure. This bearing is designed to retain much of the conformability, embeddability and nonscoring properties of babbitt and at the same time offer superior fatigue resistance.

BEARING FAILURES

Bearing failures may be cataloged into five general classifications. In the general order of their frequency of occurrence these are:

1. Fatigue.
2. Wiping and seizure.
3. Corrosion.
4. Wear and scoring.
5. Erosion.

Each bearing failure is surrounded with a set of circumstances or conditions thereby often permitting the interpreter of the facts to diagnose the trouble. Once the trouble is known the proper antidote can be applied.

Figure 3 shows a bearing with a small localized area of fatigue. The antidote to this type of failure is usually quite evident because it suggests a raised section in the

Figure 3 — Foreign material on the back of bearing caused a raised area which failed in fatigue.

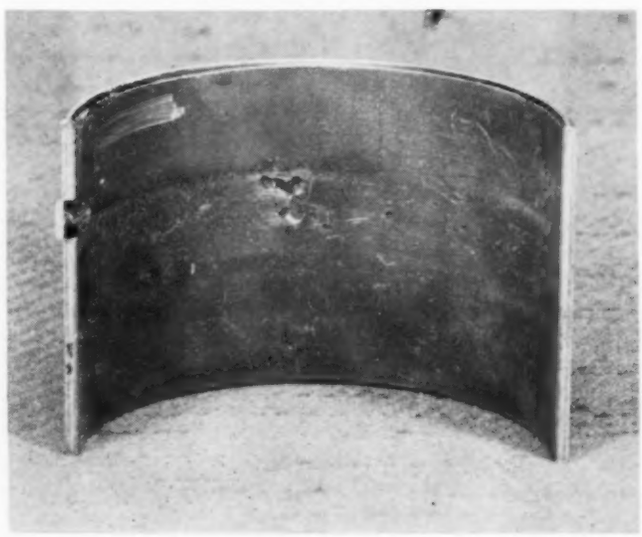


Figure 4 — Dirt on back shown caused bearing failure.

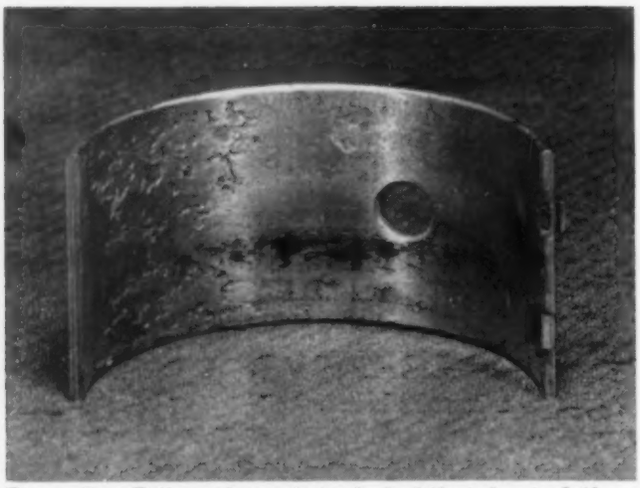


Figure 5 — Failure shown is typical of that due to fatigue from dirt embedded on inside of bearing.

bearing which could have been caused by dirt or some other foreign matter adhering to its back. Figure 4 is this same bearing illustrating the dirt embedded into the back of the bearing. The antidote for this failure would then be obvious.

Figure 5 is another illustration of a bearing which had failed in fatigue, however, this failure was caused from dirt which had embedded into the inside surface of the bearing and not the back. Although embeddability is a valuable bearing characteristic, one cannot run with dirt contaminated oils and expect the bearing's embeddability quality to absorb this off-condition without some consequence. The mechanics of this failure are that as each dirt particle becomes embedded into the bearing lining, some metal is displaced causing a raised surface. This raised surface is then repeatedly overstressed and fatigues out. The remedy for this failure is clean oil.

Figure 6 shows another failure from fatigue, however, this failure occurs from overstressing the bearing metal at the outer edges. An hour glass journal on a tapered shaft will cause such a failure. The solution is again obvious with the emphasis on good dimensional control insofar as the journal is concerned.

The mechanics of a straight fatigue bearing failure is defined to be the repeated overstressing of a bearing metal until minute cracks appear. As the number of cracks increase, small particles become liberated which are washed away by the lubricant. In brief that is what happens when a bearing fails in fatigue, however, there is another common type of fatigue failure which is caused from high temperature operation. Figure 7 is an example of a copper lead high temperature fatigue failure. Notice the dark discoloration of the steel at the bond line, indicating subjection to excessive temperatures. Not only is the appearance of a high temperature fatigue failure different, but the mechanics of the failures are also different. Here there is a dendritic copper structure slowly being robbed of its main supporting sister metal "lead" until the imposing loads are carried exclusively on an unsupported dendritic copper matrix. Since the dendritic copper structure possesses little strength, it soon bends over and breaks, enabling larger areas to fall away.

A failure of this type often times places a question

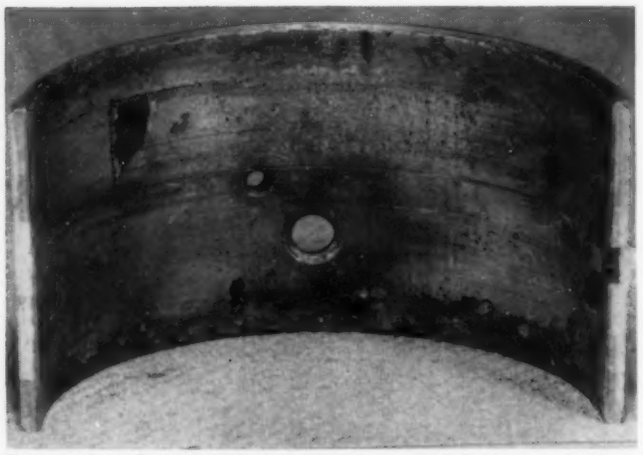


Figure 6 — An hourglass journal caused fatigue at edges due to concentration of load in this area.

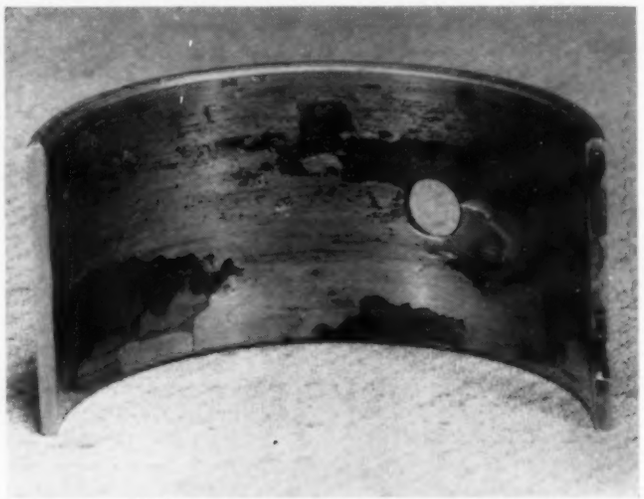


Figure 7 — High temperature has led to fatigue failure on this copper lead bearing.

Figure 8 — Excessive dirt in bearing will raise temperature and cause failure.

in one's mind regarding bond. However, poor bond between the backing material and the bearing alloy is not a common occurrence. Whereas fatigue is characterized by many fine cracks in the area of failure, poor bond usually results in a clean break of larger section. The antidote for a high temperature fatigue failure is cooler operating temperatures. Although this is easily said, there are instances where a design engineer must apply sound reasoning to accomplish cooler operating bearings. Some of the design aspects which should be checked in order to combat this high temperature operation are L/D ratio, is the bearing too long for its

Figure 9 — Failure due to insufficient clearance is shown by shiny bearing surface.

Figure 10 — Misalinement type of failure is shown here.

diameter; what are the clearances; are they what they should be; is the size of the bearing and clearance in keeping with good design insofar as the shaft speed is concerned; is there an adequate supply of fresh cool lubricant? Make sure the escaping oil is not restricting the incoming oil. Surface finish, alinement and journal dimensional control is of extreme importance and should be checked. These are a few of the facts which should be investigated before the right antidote can be determined and applied.

WIPING AND SEIZURE

Another type of failure is commonly referred to as wiping and seizure failures. Basically, wiping or seizure results from a lack of a complete oil film between the journal and bearing. This may be a temporary condition which does not lead to complete bearing failure, or it may be a progressive type of failure which ends in complete disruption of the bearing surfaces.

While identification of wiping and seizure is relatively simple, determination of its cause by visual analysis is not as easily accomplished. Babbitts and the heavy duty materials act quite differently in response to conditions initiating surface distress because of the difference in hardness of the material. Increase in fatigue life gained by the heavy duty copper lead, silver and relative materials is accomplished through some sacrifice of surface running characteristics.

Complete seizure of babbitt bearings is rare, and happens only if the operator fails to notice an accompanying loss of oil pressure, temporary increase in operating temperatures, and an increased level of engine noise. If seizure does occur, the journal may weld to the steel back after the babbitt has been displaced.

Dirt embedded in the babbitt bearing to a degree greater than the babbitt can effectively accommodate, as shown in Figure 8, will score and abrade the bearing journal which results in an increase in surface temperature. Determination of the type of dirt is a useful bit of fact which could be used in locating the source of dirt thereby applying the proper antidote.

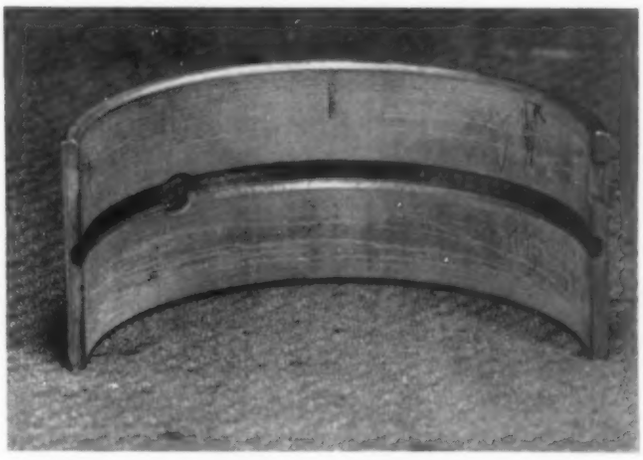
Figure 9 is an illustration of a wiped bearing surface caused by insufficient initial clearance. A good bearing surface operating under satisfactory conditions has a dull appearance. In many cases the surface is coated with a varnish formation or protective film of various shades depending on the type of oil used. When, as here, the surface is shiny or lightly wiped, the oil film has not completely separated the journal. Again, analysis for the cause should include investigation of operating temperatures and measurement of mating parts for improper assembled clearances. Micrometer measurements of the bearing wall alone is not sufficient to determine proper clearance in a given bore. Accurate measurements of the bearing assembled in the bore should be made since the press fit of the bearing usually distorts the bore to give increased clearances over those obtained by blueprint calculations.

Wiping and subsequent seizure may occur if there is misalinement between the journal and its bearing. This happens because the load is not evenly distributed and the resulting edge pressures force the shaft to break the oil film. Figure 10 shows a bearing with a tapered shaft condition which has caused a partial decrease in clearance with resultant wipe of the babbitt until a new surface has been produced which will redistribute the load over a greater area. This is one condition in which babbitt has an advantage over high fatigue strength alloys.

CORROSION

Corrosion is another type of bearing failure which has occurred repeatedly in some applications while in others it is practically unheard of. Among the many types of bearing failures, corrosion is probably the most difficult to identify by visual inspection. Actually, complete metallographic checks combined with X-ray and bearing fracture tests are required for positive identification, since the structural changes cannot be seen with the aid of relatively low power magnifying lenses. Corrosion is doubly difficult to detect because it frequently results in early fatigue because of a weakened structure. The best visual clue offered for identification is in the location of the surface distress. Generally, except in cases occurring because of exposed protective layers, corrosion will attack the complete bearing surface, while fatigue is usually concentrated in a given area.

Figure 11 — Corrosion failure of lead-base babbitt is indicated by fine grayish powder on surface.



In the case of corrosion of lead-base babbitt, which is rare, but possible with some lubricants, a fine greyish, powdery surface may result, as illustrated in Figure 11 (corrosion of tin-base babbitt is practically unheard of).

The unloaded half of such a bearing assembly may be wiped with the fingers under heavy pressure with resultant transfer of powder from the babbitt. Washing of this material by the lubricant transfers it through the lubricating system where it may appear as deposits in radii, pump and filter screens, or as a grey coating in the oil pan. In such cases, if corrosion is suspected, a sample of the oil submitted for chemical analysis will aid in detection of corrosive by-products.

The overlay of the trimetal bearing not only is effective in reducing surface sensitivity to seizure and increasing fatigue life, but also offers protection from corrosion. Because of the usually good resistance of babbitt to corrosion, the copper-lead layer is not exposed, unless scored or worn through. When the copper-lead layers are subjected to corrosion, the free lead between the copper dendrites is ordinarily the element attacked. Usually this leaves a red appearance to the surface, and for that reason a metallographic, X-ray, and fracture analysis is the only certain method of identification. Scratch penetration of several successive layers may be of some use for visual determination, but it is only a tool for use by one who is widely experienced, since there is a possibility of overlapping of color shades leading to confusion.

After corrosion begins, the normal structure is weakened and continued breakdown of the surface will lead to premature fatigue failures as illustrated in Figure 12. This type of failure is often confused by the uninitiated with ordinary fatigue.

Once the bearing failure has finally been identified as corrosion, the next step is to find the cause so that the proper antidote can be applied. Attempting to find the cause presents a serious problem. Abnormally high engine temperatures on one hand cause rapid increase in oxidation of lubricants, while continued cold operating also can result in formation of corrosive elements from decomposition of fuel in the presence of crankcase condensation.

Figure 12 — Combination of fatigue and corrosion causes bad bearing failures.

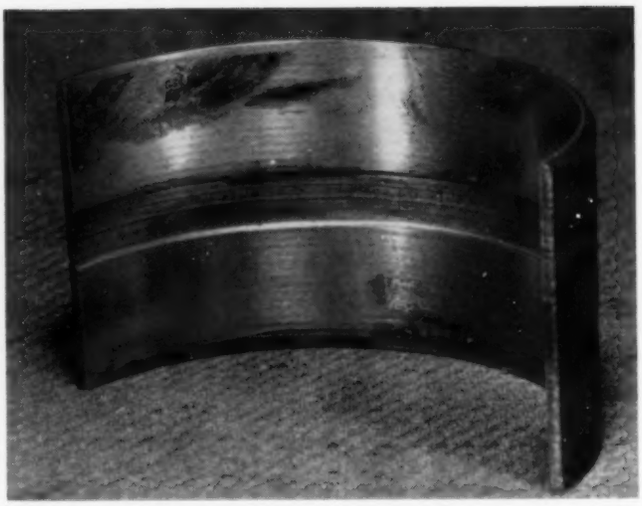


Figure 13 — Fretting corrosion apparently causes failures due to vibration breaking down thin oil film.

The proper solution here is not obvious, especially when simple economics may come to bear on the final decision. More frequent oil changes may alleviate the condition, or properly fortified premium oil may be the answer; on the other hand, one might be further ahead economically by reducing the oil changes and setting up a periodic bearing change-out schedule. The selection of the proper antidote often times requires studying, however, it must be mentioned that the bearing and oil manufacturers have made tremendous strides in combatting this problem. The bearing industry has successfully concocted copper-lead bearing alloys which possess a matrix which effectively resists accelerated corrosion.

Fretting corrosion shown in Figure 13 is not peculiar to bearings, but may occur on any two mating machine parts, appears in a form typified by its descriptive name. It most frequently appears on applications where the journal and bearing are thought to have little relative motion, but where induced or forced vibrations are present. Common examples of such applications are on guide bearings, axle bearings, and king pin bushings. The high frequency vibration present in such applications may break down the oil film and cause direct transfer from one metal to the other. Prolonged fretting between the two materials may result in a dark oxide formation in conjunction with a disruption of the surface. When such cases are suspected, the direction and location of the load should be examined, and a search for a possible source of induced vibration should be made.

WEAR AND SCORING

Wear and scoring may be a particular type of failure by itself, or more usually it is only an intermediate stage which will progress further to wiping, seizure, or premature fatigue, depending on the type of bearing material and the severity of service. The majority of all bearing failures are initiated by the introduction of dirt into the engine lubricant, as pictured in Figure 14.

Visually, there is no problem in identifying wear and scoring of the bearing, since the degree of wear is easily checked by micrometers, and scoring is more than ob-

Figure 14—Majority of bearing failures are started through the introduction of dirt into the lubricant.

vious. The source of the foreign particles is a different matter. Here again, it is extremely important to have access to the engine in order to locate the origin of the dirt. Operational and overhaul history of the engine should be examined. The most frequent source of dirt is from improper cleaning of the engine during maintenance. In such cases, metal chips or grinding or lapping compound may not have been carefully removed. Such material in a bearing surface may abrade and wear shafts as well as lapping the bearing surface. This results in excessive clearances and high oil consumption.

Proper maintenance of oil and air filters is a must for increased bearing life. When shaft surface finishes are too rough, as pictured in Figure 15, the high peaks of the journal may actually contact the bearing surface when the oil film thickness reaches its maximum value. In the case of babbitt, the grind pattern on the journal may be transferred to the bearing surface. On the other hand, a heavy duty bearing may not react by wearing but fail in seizure. Often times a journal is ground to a rather good acceptable RMS finish; however it is still unsuitable for good bearing life. Following a grinding operation, there usually remains an undetectable fuzz which should be removed by some polishing operation. This fuzz does not usually affect a smoothness reading, and therefore, is easily overlooked.

The antidote for these types of failures requires little mental effort except perhaps in locating the source of the number one enemy of bearings, dirt, and by maintaining smooth journal surfaces.

EROSION

A more infrequent cause of bearing failure is erosion. It may appear in a simple form with a washing action on the bearing surface, leaving a hen-tracked pattern, probably from the pressured flow of lubricants with or without foreign particles; or it may appear as a mysterious phenomena popularly called cavitation erosion.

In Figure 16 is seen an advanced case of erosion in a cut-open bushing from a gear train component. Careful visual analysis with a low-power magnifier will show an irregular depth to these pitted areas. In general, erosion leaves the bottom and sides of such cavities much smoother than similar cavities produced by fatigue, with freedom from cracks.

This type of erosion is most commonly found in bearings associated with gear trains, or applications of high rotational speeds with high frequency shock loads.

Figure 15 — Failure shown is due to rough surface finish on shaft.

One of the really mysterious things about erosion is that it does not stop with the relatively soft bearing material. In systems where it appears, it may attack mating parts as well. It has been known to eat into steel shafts and cause fatigue failures of high speed rotating parts as well as appearing in simple form.

In the case of gear trains, such things as changes in lubricant viscosity, breaking-up the velocity of lubricant flow, and improving gear tooth engagement, have improved bearing performance.

DESIGN FOR GOOD BEARING LIFE

Up to this time, this paper has discussed just a few of the ordinary things that can happen to a sleeve bearing. Actually, things are not as deplorable as all these figures might indicate. Most failures occur from the lack of regularly applying two of the most important antidotes against sleeve bearing failures. In the broadest sense, these two antidotes can be classified as:

1. Good design.
2. Good maintenance.

This may appear as an over-simplification of the problem, however, the writer's close association with

Figure 16 — Illustration shows erosion failure on gear bushing.

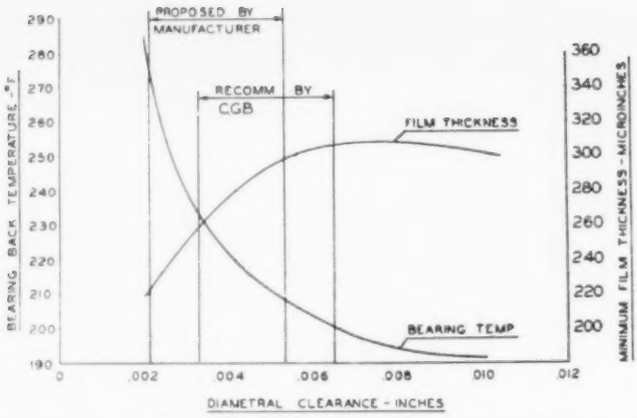


Figure 17 — Curve gives bearing back temperature and minimum failure thickness as a function of the diametral clearance.

bearings over the past years has enabled him to conclude that good design and good maintenance can be the answer to most bearing problems.

Beyond the outlined antidotes to the many illustrated bearing failures, it is possible to become involved in the finer bearing design aspects which usually go into the design of a bearing and which usually require the experience of a bearing design specialist.

After seeing all of these many and varied sleeve bearing failures, one may possibly lose some confidence in the sleeve bearing's ability to perform satisfactorily. To instill a feeling of assurance regarding sleeve bearings, the following will briefly outline a few of the many design considerations which are investigated before final approval is given to a set of recommendations.

In the bearing industry, this bearing design investigation is called "Load and Lubrication Studies." These design studies are primarily to establish proper bearing operating temperatures and oil flow requirements to give good bearing life, and to establish proper dimensions which will prevent mechanical failures during the life of an engine. A plot of proposed bearing clearances versus bearing temperatures and oil film thickness can be calculated from loads, speeds, and lubricant viscosity as shown in Figure 17. This will insure operation under optimum conditions for a particular application.

A series of curves, taken from engine polar diagrams showing maximum rod bearing loads plotted against engine rpm, as in Figure 18, is a great help in deciding what material is required to give a maximum performance in fatigue. Also on Figure 18, is a curve showing actual oil flow. This points out the lugging load zone where load is high while oil flow is critically low.

When the load and lubrication study has established clearances, oil flow, and materials, the bearing housing may be examined and assembled with bearings of varying press fits to determine what amount of bearing crush or excess circumferential length is required to seat the bearing firmly in the bore. An illustration of what crush is, is illustrated in Figure 19.

Insufficient crush leads to movement between the seat and the bearing back resulting in fretted steel backs on the bearing and housing surface. This may

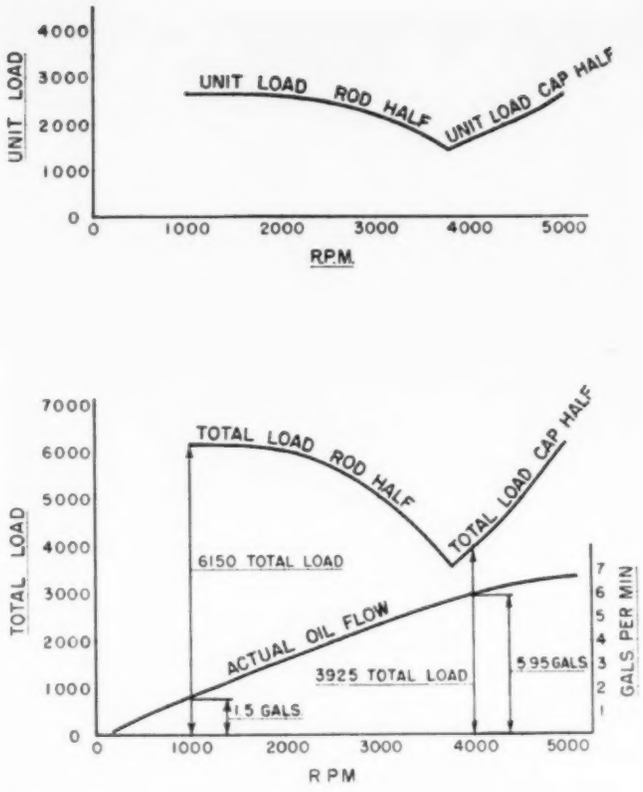


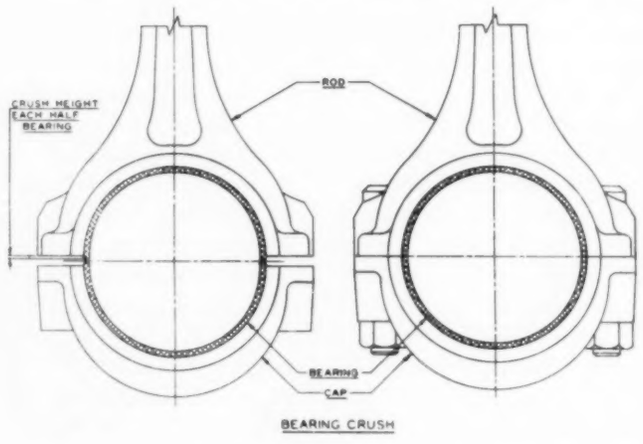
Figure 18 — Chart shows maximum connecting rod loads as a function of the engine rpm.

cause bearing seizure or plain mechanical destruction from interference. Figure 20 is an example of a steel back bearing fretting. On the other hand, too much distortion of the bore from high press fit may cause a horizontal bore "close-in" with resultant pinch of the shaft at the bearing parting lines.

Both this condition and that of close-in, due to breathing of connecting rods under inertia loads, are easily corrected by designing the bearing with an eccentric wall which is thinner near the parting lines to give proper horizontal clearance.

Besides these few considerations, there are a great many detail investigations that go into designing a bearing which is beyond the scope of a paper of this length.

Figure 19 — Bearing crush is the excess circumferential length required to seat the bearing firmly in the bore.



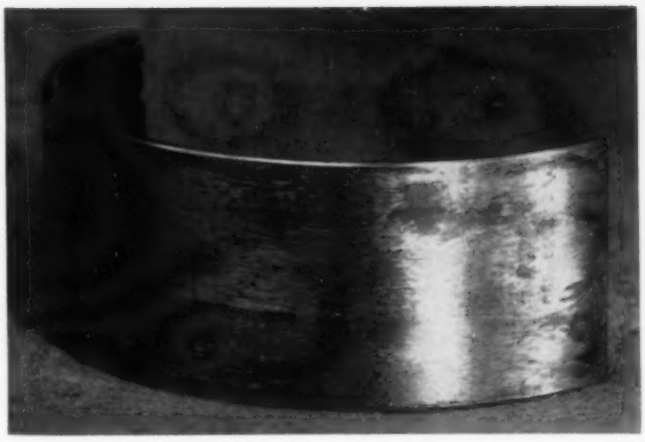


Figure 20 — Fretting in a steel back bearing is illustrated here.

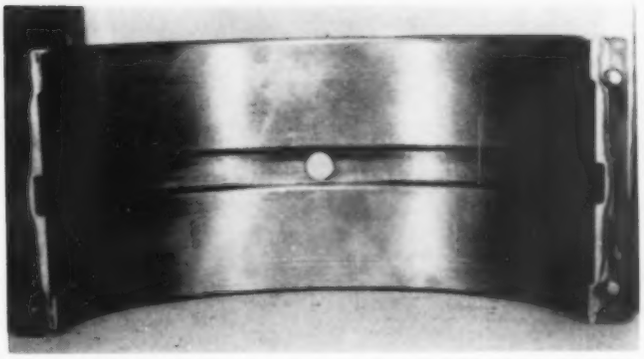


Figure 21 — Most bearings, however, give trouble-free performance. The locomotive diesel bearing shown has operated over 1,000,000 miles.

SUMMARY

In conclusion the folowing advice is offered to those who are confronted with bearing troubles. Save every clue! If possible, lay out the components on a large table in their relative assembled position, examine the good pieces as well as the failed ones, and try to correlate engine history and performance with the story the bearings have to tell. Keep an open mind and do not be too quick to pass judgment, for not always is a bearing's condition of its own making.

DISCUSSION

PRESENTED BY

THOMAS COLBRIDGE, Chief Engineer, Johnson Bronze Co., New Castle, Pa.

ANTHONY F. KAMINSKAS, Product and Field Engineer, Cleveland Graphite Bronze Co. Division of Clevite Corp., Cleveland, Ohio

C. T. LEWIS Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio

Thomas Colbridge: There is a material which I would like to hear Mr. Kaminskas discuss, that is, the aluminum bearing and the aluminum on steel bearing.

Anthony F. Kaminskas: In respect to the aluminum bearing, I would like to say that there has been a great deal of interest shown in the aluminum constructed bearing. The extensive interest in this bearing, I believe, can increase or decrease as time passes, depending on its performance in presently selected test engines.

To stay abreast with new bearing materials, we have been working with the aluminum bearing for approximately 15 years. Our steel backed aluminum bearing, as I have seen it, has gone through various experimental stages and will most probably pass through other development stages.

We feel that the aluminum bearing will definitely come into its own and assume a deserving seat among the presently established bearing materials. Its acceptance as a bearing material, because of its availability is inevitable; however, the time interval before its use becomes widespread, depends on many factors. Some of the factors that control the performance of the aluminum bearing are its high rate of thermal expansion, surface action, and seizure characteristics. These characteristics, along with the design and others, must be closely evaluated for maximum performance and compatability.

We feel that eventually there will be a family of aluminum alloys, just as we have a family of copper lead and babbitt bearing alloys; each being best suited for a range of particular applications. To date this has not been accomplished with the aluminum bearing alloys.

In conclusion, I would like to say that the aluminum bearing will undoubtedly be in our future; however today, acceptance is primarily confined to carefully selected applications.

C. T. Lewis: There is one question I would like to ask. The paper referred to a bearing being too long with respect to the diameter and, appreciating the problem of alinement, I am wondering if you had any thought in mind in that regard.

Anthony F. Kaminskas: Whenever the length of a bearing is out of proportion with its diameter, you have another problem besides alinement. Since most bearings receive their supply of lubricant through a hole or annular groove in the center of a bearing, a temperature problem will predominate if the length of each bearing land is too long for its diameter. In general, a good L/D ratio ranges from 0.5 to 0.8, however, since there are so many design factors which govern the final set of recommendations, the above rule should be used judiciously.

This same line of reasoning is also true regarding steel mill equipment bearings, however, I believe the problem there is not quite as critical since the speeds are usually slow with adequate bearing area for the imposed loads.

This same problem in the automotive and diesel fields has reversed somewhat. Since the engine horsepower ratings have gone up with decreased engine block sizes, the length of the bearings in comparison to their diameters is usually on the short side of good design rather than too long.

In addition to alinement and heat generation, large L/D ratio bearings present other problems such as tapered journals, out of roundness and in general lack of dimensional control. Any and all of these factors can be detrimental to satisfactory bearing performance when beyond the limits of accepted standards.

By D. O. DAVIS, Vice President Engineering, Dominion Foundries and Steel, Ltd., Hamilton, Ontario, Canada

The Oxygen Steelmaking Process

. . . . in building of new steel plant equipment, care should be taken that the emphasis is not placed on having the largest, fastest and most powerful units . . . . it is better to build with an eye on obtaining maximum return from capital investment . . . . oxygen steelmaking provides additional steelmaking capacity at lower capital and operating costs and also gives good quality steel . . . .

▲ FACED with the necessity of expanding steelmaking capacity, Dominion Foundries & Steel Limited several years ago conducted engineering studies of the various steelmaking methods. These studies included:

1. Open hearths.
2. Electric furnaces using blast furnace hot metal.
3. Duplexing—bessemer and open hearth.
4. Duplexing—bessemer and electric furnaces.
5. Duplexing—oxygen jet steel and electric furnaces.
6. Oxygen jet steel, direct.

After considerable study of all six schemes, the field was narrowed down to schemes No. 5 and 6. Then, after learning more about the high quality steel made by the oxygen process in our experimental vessel, the idea of duplexing oxygen steel in the electric furnace was eliminated.

The steel industry is facing a day of awakening with respect to the low return on some capital expenditures. A wild race has been going on to build the fastest, longest, highest and widest processing units without paying sufficient attention to return on capital investment.

The oxygen steelmaking process is a good lesson in basic economics for all of us to stop and review, as we have just 50 per cent of the equipment cost of competitive processes for the same tonnage, with somewhat lower operating costs, and with equal or, on certain applications, better quality resultant product.

For example, a shop containing four 250-ton open hearth furnaces will produce at an average rate of 100 ton of ingots per hour. On the other hand, an oxygen steelmaking plant, with three 40-ton vessels—two on and one down for rebricking—and working on 45-minute cycles can easily produce ingots at the same rate of 100 tons per hour. However, the oxygen steel plant, including the oxygen plant, can be built for less than 50 per cent of the cost of the open hearth shop.

At Dofasco, we were all generally satisfied with the oxygen method of steelmaking but had two major questions to be answered:

1. Metallurgically, was the oxygen jet steel satisfactory?
2. Could the dust collection problem be solved?

To answer both of these questions, an experimental 8-ton vessel was installed and put into operation. By producing an average of 20 heats per 24 hours in this unit, over a period of months, it was possible to get considerable tonnage processed by our customers and, thereby, get an approval of this new steel.

Good use was made of the experimental vessel to

Figure 1 — The steelmaking, blast furnace and coke plant departments are located in the same area. Rolling mills are over one mile away from this site.

clarify planning and thinking about the dust problem. By a process of elimination we arrived at the combination of a cyclone separator system, along with a Dofasco stack and cooling box design.

The design of the dust collecting system on the large vessel was altered very little after start-up, due, of course, to the work on the small vessel.

showing the relative location of the major equipment and the flow of materials through the department. Scrap is delivered into the upper end of the building by railroad car and truck. It is then loaded into chute-type charging boxes 4 ft wide x 18 ft long x 3 ft deep. These boxes are dumped into the steelmaking vessels as desired by an overhead crane (Figure 3).

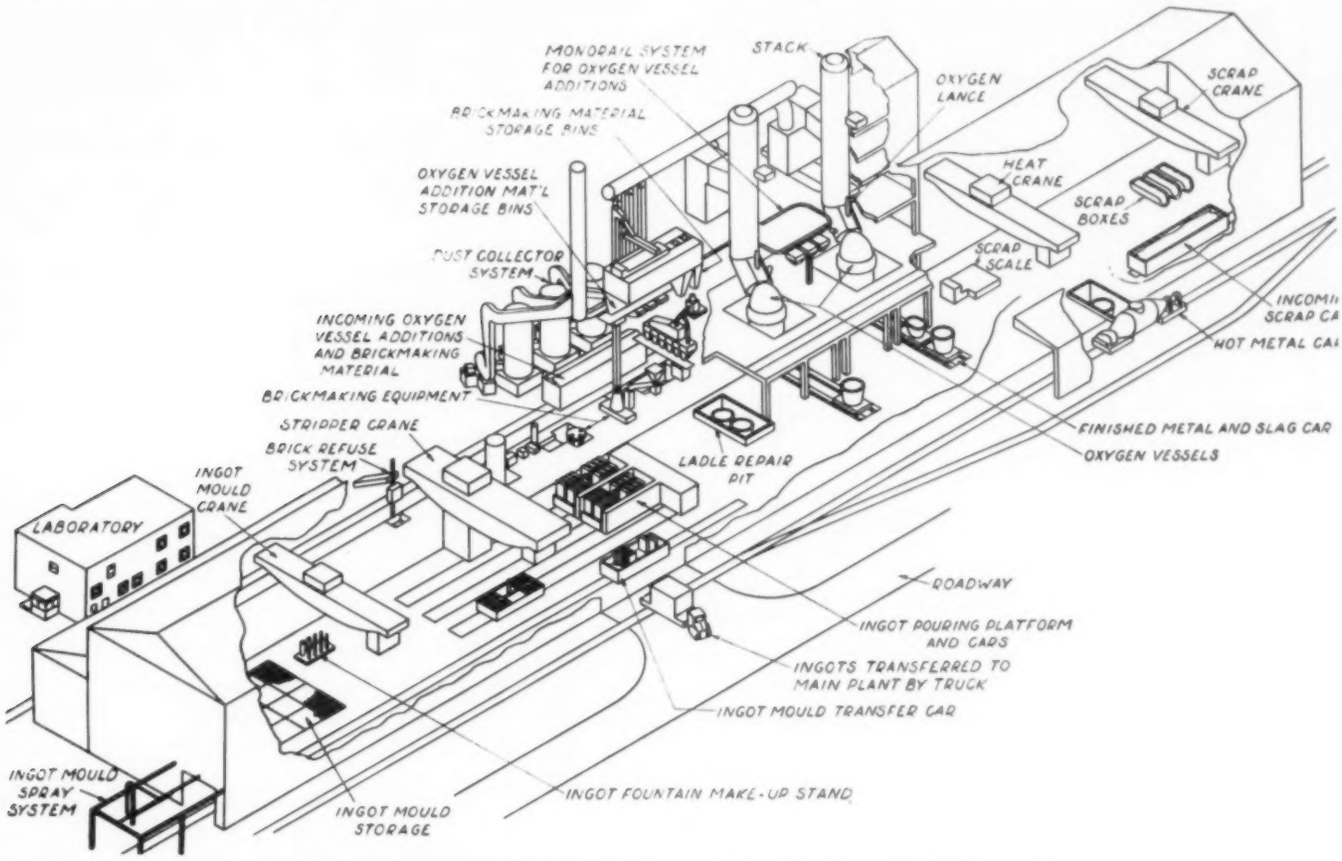


Figure 2 — Schematic sketch shows flow through oxygen steel plant department.

For those who are not familiar with the principles of the oxygen process a brief description may be of value:

1. This type of steelmaking takes place in a one piece, open top vessel—free to rotate on trunnions.
2. High purity oxygen, at a pressure of 5 to 10 atmospheres, is blown downward on the surface of the molten iron bath.
3. The reaction taking place between the oxygen and the surface of the bath is extremely violent and results in very high temperatures and gas velocities.

The oxygen is introduced to the bath through a water cooled jet or lance, with its physical dimensions being a function of vessel dimensions and desired heat time.

Figure 1 shows the Dofasco oxygen plant in the foreground and the steelmaking plant in the distance. Both of these departments are located on the same property as the Dofasco blast furnace and coke plant, making it convenient to deliver blast furnace metal to the steel plant. The rolling mills and finishing departments are located about 1¼ miles from this site.

Figure 2 is a diagrammatic view of the steel plant,

Hot metal is delivered from the blast furnace in 150-ton mixer type ladles to a leanto building just beyond the steelmaking vessels. The hot metal is poured as needed into a hot metal ladle on a pit transfer car, and then moved into the main building. Here the ladle is picked up by overhead crane and transferred to the steelmaking vessels.

The main aisle of the building contains four cranes; one to service scrap and hot metal, one to pour heats, a new design 450-ton oil-hydraulic stripper crane which can handle molds, ingots, etc., and a crane to handle ingot molds in and out of storage.

The steelmaking shop is equipped with two vessels, with just one working at a time while the other vessel is being relined. They are of one-piece design, using 2-in. plate, and are 14 ft outside diameter and 25 ft in height. Magnesite brick is used for the permanent lining and weighs 30 tons; it is backed up with fire clay. The working lining is made up of 100 ton of "Dofasco made" tar dolomite brick, with a backing of rammed tar dolomite.

The working volume of the vessel, with a new lining, is 1150 cu ft. This volume increases to 1650 cu ft as the work lining wears out.

For a 45-ton charge, the depth of bath varies from

Figure 3 — A long, narrow box is used for charging scrap into the converter.

42 to 30 in. as the lining of the vessel changes.

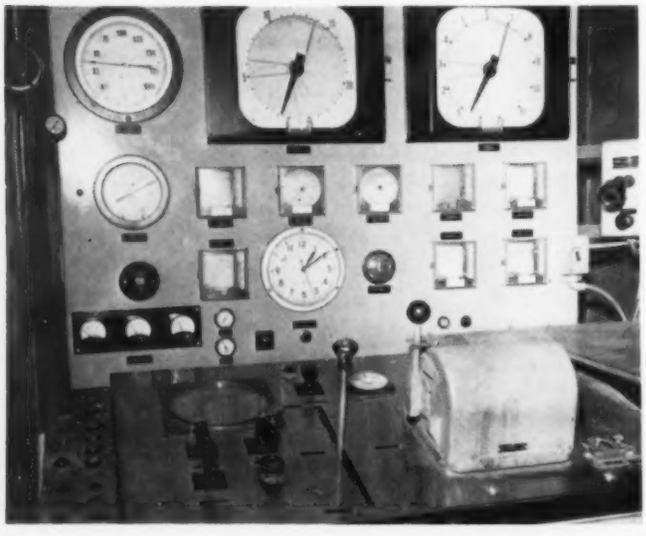
The average lining life is 180 heats, but a life of 250 heats is expected with improved practice.

Each vessel has a separate lance hoisting mechanism, with a third system operating between the two vessels.

The vessel is tilted by two 150-hp mill type, shunt motors operating in parallel. Each is capable of tilting the vessel independently and, should one motor fail, the operator may select the sound motor by means of a desk-mounted selector switch and continue his pour.

Power to the drive motors is supplied from either of two 150-kw motor-generator sets, which may be selected at the operator's desk (Figure 4). Normally generator No. 1 will be used by control desk A; however, should desk B require that generator due to a failure of No. 2, he need only press a button "requesting a generator." This lights an indicating light on desk A; the operator at desk A will then turn his generator selector switch to neutral on completion of his cycle, and desk B will gain control of generator No. 1 through his selector switch.

Figure 4 — Power for drive motor comes from two 150-kw motor-generator sets, controlled from the operator's desk.



The main use for this system, outside of emergency conditions, is for the ultimate melt shop capacity of three vessels at which time the two generators will supply power to three drives by means of selection as described.

The vessel drive itself consists of a rotating regulator controlled variable voltage system, regulating generator voltage against a reference voltage supplied by a master switch mounted in the operator's desk. Since this voltage regulator will compensate for the voltage drop due to current flow, the regulator essentially regulates the speed of the drive motors.

The master switch reference voltage is supplied from an ohmite rheostat providing a large number of speed points depending on the displacement of the handle from the center or stop position. Since the rotating regulator reference field is connected to the slider of the ohmite rheostat in a bridge circuit, the drive can be reversed by moving the master switch from center in the opposite direction.

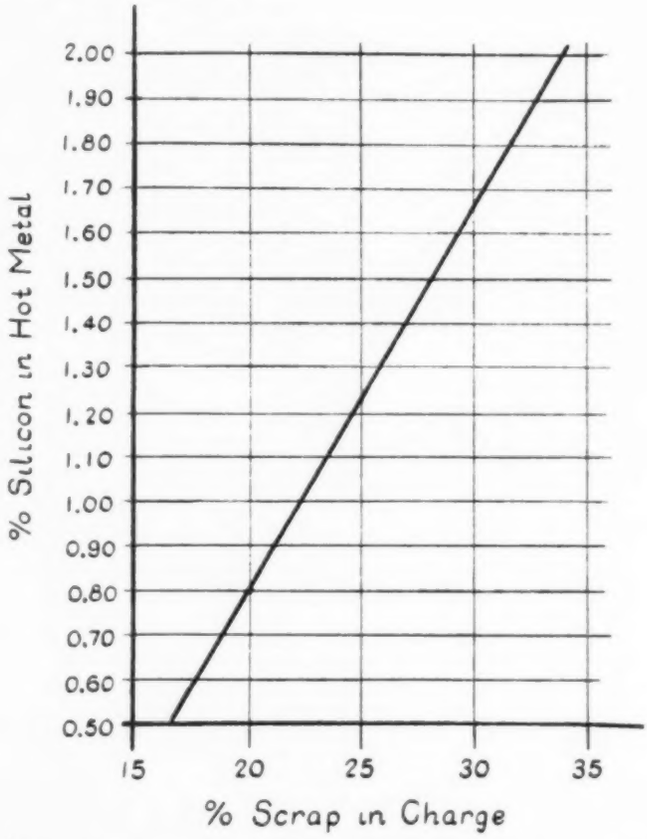


Figure 5 — Per cent of scrap in the charge can increase as the silicon increases in the hot metal.

The control is equipped with a current limit circuit so that when rapid changes in speed are called for at the operator's master switch, the drive will accelerate or decelerate at a maximum rate while holding current within the peak rating of the electrical equipment.

On moving the master switch to the center or stop position, electrical brakes connected to shaft extensions on the drive motors stop and hold the vessel at any position. The operator can make use of regenerative braking by returning the master switch to a minimum speed position before centering it.

The drive may be stopped and reversed under full

current by moving the master switch through center to the opposite side. By this method the furnace may be "rocked."

Operation of the oxygen lance hoist is accomplished at the operator's desk by means of a master switch with three speed points hoisting and lowering. The drive is a 25-hp series wound mill type motor controlled from a constant potential panel and incorporating dynamic braking. A cam type rotating limit switch with ten circuits controls the lance in slow down zones and sets the top and bottom limits to lance travel.

The lance and tilt drive are so interlocked that the lance cannot be lowered until the furnace is in the upright position. Similarly the furnace cannot be tilted while the lance is lowered.

and 3:1 ratio of lime to silica, with silica the variable if the ratio gets out of balance.

Mill scale is added to the extent of 1 per cent of the metallic charge and between 100 and 200 lb of spar is charged as desired by the melter.

Dolomite and miscellaneous materials are delivered to the plant by rail or truck and then elevated to overhead storage bins. Figure 6 shows diagrammatically the method of unloading these materials from railroad cars or trucks into a track hopper, then into an elevator and then into storage bins which are located in the same building as the steelmaking vessels. A power-operated monorail system, consisting of four separate hoppers and a "man-cab," deliver addition to either of the two vessels as required. Specially designed water-cooled chutes are located just above the vessels.

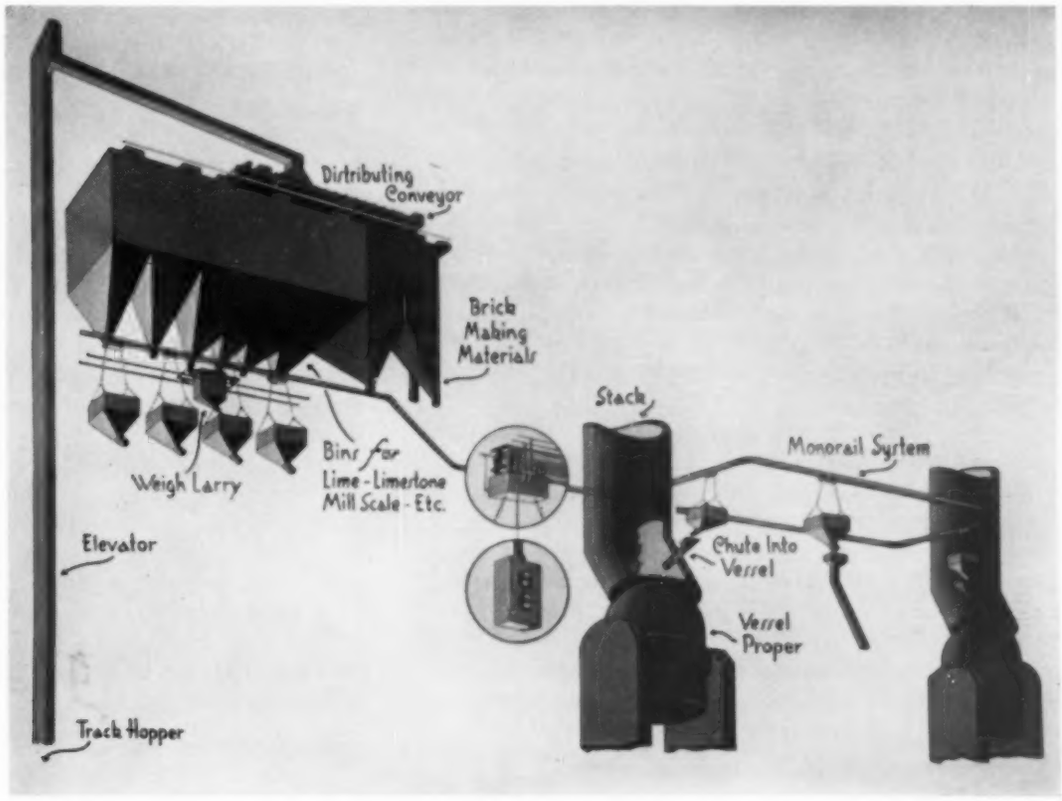


Figure 6 — Illustration shows scheme of making additions in the oxygen steel plant.

Dofasco hot metal averages 1.3 per cent manganese, 1.20 per cent silicon, 0.125 per cent phosphorous, 0.025 per cent sulphur, and 4.4 per cent carbon. We have operated successfully with silicon varying in the iron from 0.50 to 2.00 per cent and phosphorous running as high as 0.180 per cent.

The percentage of scrap charged is a function of silicon content and temperature of the blast furnace metal. Figure 5 shows a relationship between the silicon in the iron and the scrap in the charge. Operating experience at Linz and Dofasco indicate that this chart is reasonably accurate. Part of our operating procedure is to check the silicon content of each charge of blast furnace iron as it leaves the mixer car on its way to the vessel. An automatic spectograph and pneumatic tube system are used for this purpose.

The silicon information is also used as part of the slag control program, which aims at the same weight of slag per ton of steel and the same slag analysis for every heat. Normal practice aims for 7 per cent charge

and extend through the waste gas collector hoods to handle these additions. One man operates this "additions" system.

Approximately 20 lb of dolomite is used per ton of ingots, considerable less than open hearth consumption.

After the vessel is charged and turned upright beneath the dust-collector hood, the oxygen lance is lowered and the blast is turned on. The oxygen "on-time" is 22 minutes per heat, with a total tap-to-tap time of 45 to 50 minutes. Oxygen consumption is approximately 1850 cu ft per ton of steel produced.

Practically all ingots are bottom poured on three specially designed cars. This arrangement permits pouring all heats at one station, stripping ingots at another, and cleaning the bases, rebricking, setting up molds, etc., in other stations.

The average heat, originally 40 ton but now up to 50 ton, is poured on one base with a single center fountain, with an average of 8 to 12 ingots per heat.

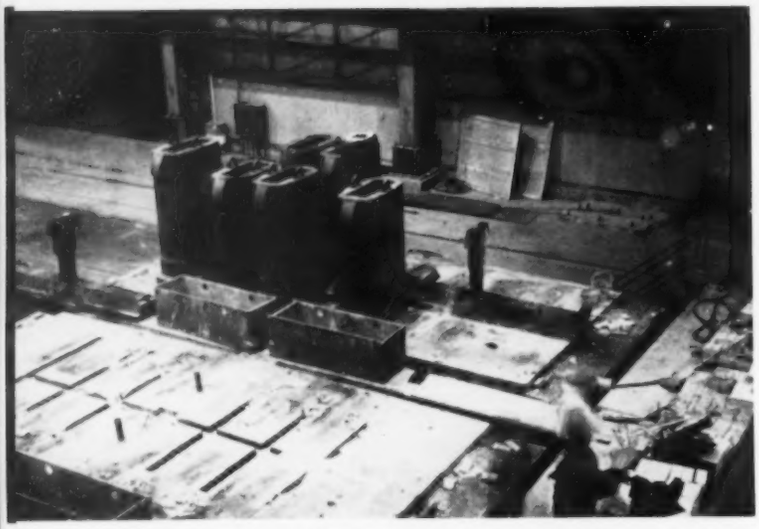


Figure 7 — Practically all ingots are bottom poured on special cars.

Figure 7 shows two of the bottom pour cars—one stripped and with the runner brick partially removed, the other with a heat partially set up.

As the Dofasco two-high roughing mill is on the light side, ingots are 14 in. and 17 in. slab type. Strip is then rolled direct, down to an average of 0.100 in. and a minimum of No. 16 gage, on a two-stand setup. It is interesting to note that no money is spent for ingot or slab conditioning.

Because of not having a company-owned railroad between the steelmaking plant and the rolling mills, it was necessary to do some original planning along the line of motor trucks for the transportation of ingots. The insulated truck, shown in Figure 8, has worked out very well from both the standpoint of operating costs and track time. Our Btu consumption in the soaking pits has been reduced 25 per cent over delivery by rail—within the same plant—as originally practiced. Each truck carries one half of a heat of ingots.

As molds are stripped, they are placed on a specially designed mold transfer car for direct return to storage or for delivery to a mold spraying station. The mold transfer car movement is controlled from the cab of the stripper crane.

There is a track under each vessel running from the main bay into a slag yard. In this yard, the slag pots are removed from the special slag cars, allowed to cool, and then loaded on a specially designed self dumping truck, as shown in Figure 9. There are sufficient slag pots on hand to require the use of this truck just on the day shift.

The dust collector system, shown in Figure 10, consists primarily of a brick-lined, water-cooled hood and a 124-ft stack over each vessel. At a height of 90 ft above floor level, a brick-lined duct feeds the waste gases into a double compartment steel cooling box of 30 ft x 23 ft x 10 ft overall dimensions. A series of water sprays, operating at 150-psi pressure and using 260 gpm of water, are installed in each of the cooling boxes.

The waste gases then move into a collector main which runs horizontally across the top of the two cooling boxes, and are then transferred downward through venturis, each approximately 12 in. x 60 in. Medium pressure water sprays are located in the throat of the venturis. Two venturis are used at one time, with each consuming 750 gpm of water.

The waste gases then continue downward into two cyclonic separators, each 12 ft in diameter and 30 ft in height. There are three separators in parallel, only two of which are used at any one time, with the third serving as a stand-by. Fans (70,000-cfm each) on the delivery side of the separators pull the cleaned gases through the separators and then exhaust them through a common stack to the atmosphere.

The waste gas volume ranges from a minimum of 110,000 cfm at 65 F to 120,000 cfm at 115 F. The first volume occurs about three minutes after "oxygen-on," and the second volume fifteen minutes after "oxygen-on." Dust concentrations range from a minimum of 0.223 gr per cu ft at 105 F to a maximum of 0.402 gr per cu ft at 111 F at the exhaust stack. The dust concentration in the stack over the steelmaking vessels is 7.0 gr per cu ft. Average temperature in the main stack over the vessel is 1600 F.

The success or failure of the oxygen jet process of steelmaking naturally depends heavily on the oxygen

Figure 8 — A special insulated truck is used for moving ingots from the steel plant to the rolling mill. Heat loss is less than on conventional trains.

Figure 9 — A self-dumping truck is used to handle slag pots.

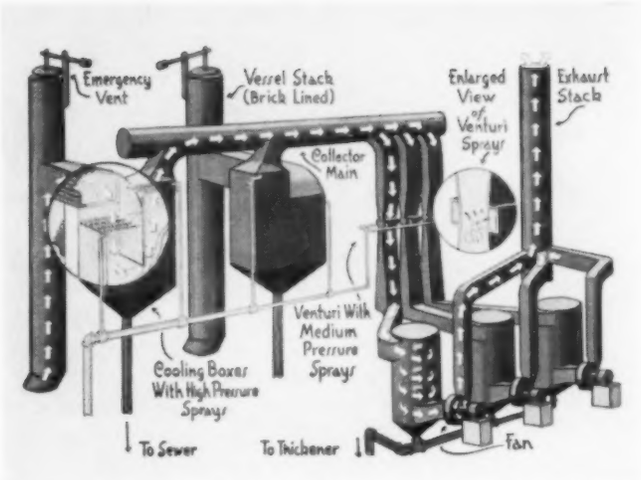


Figure 10 — One of the problems which was solved was that of collecting the dust from the oxygen steel plant.

plant. The Dofasco oxygen plant is a high-purity unit that has produced 100 tons of oxygen per day, with a purity of 99.5 per cent, and power consumption of less than 400 kwhr per ton of oxygen.

In this plant centrifugal compressors are used to compress the air feed to 80 psi absolute; 70 per cent of this air is sent directly at this pressure to the reversing nitrogen regenerators. These generators are towers packed with specially designed corrugated aluminum ribbons which act as accumulators, to cool the air feed down to about 245 F, the ribbons having been previously cooled by the by-product nitrogen stream. The flow of the warm air feed and cold by-product nitrogen are alternated in the two regenerators at approximately three minute intervals.

In cooling down the air feed, the carbon dioxide, water vapor and some hydro-carbons are deposited on the aluminum packing in liquid or solid form, and will eventually be carried out of the plant by the by-product gas during the reversing cycle.

The cooled air then leaves the regenerators, free of all impurities; otherwise the following low temperature air separation equipment might become plugged.

The remaining portion (30 per cent) of the air feed is boosted to a higher pressure and the carbon dioxide removed by scrubbing the air with caustic soda in a packed tower. This stream is then dried by refrigeration in reversing, conventional tube-and-shell exchangers against the high purity oxygen product. The moisture deposited in the exchangers is derimmed and purged out during the reversing cycle.

The reason for standard exchangers instead of the regenerators as for the nitrogen stream is that the high purity product must not be contaminated by the impurities deposited by the feed stream.

The portion of air from the nitrogen regenerators is sent directly to the bottom of the high pressure column, while that of the oxygen circuit is divided, part being further cooled to liquefication and sent to the high pressure column to provide for additional reflux, and part being expanded in a reciprocating expansion engine down to column pressure with the temperature dropping from –145 F to about –280 F. The latter portion then joins the main stream and is sent to the high pressure column.

The mixture of expanded air and liquid air in the high pressure column is separated into an almost pure gaseous nitrogen fraction at the top and a liquid rich in oxygen at the bottom. The nitrogen is liquefied in the vaporizer located atop the high pressure column. This is done by means of heat exchange by the vaporization of liquid oxygen from the low pressure column surrounding the vaporizer tubes.

Part of this liquid nitrogen is used as a reflux in the high pressure column; the remainder is sent to a subcooler where it is cooled by out flowing pure nitrogen and then expanded and sent to the top of the low pressure column as a reflux.

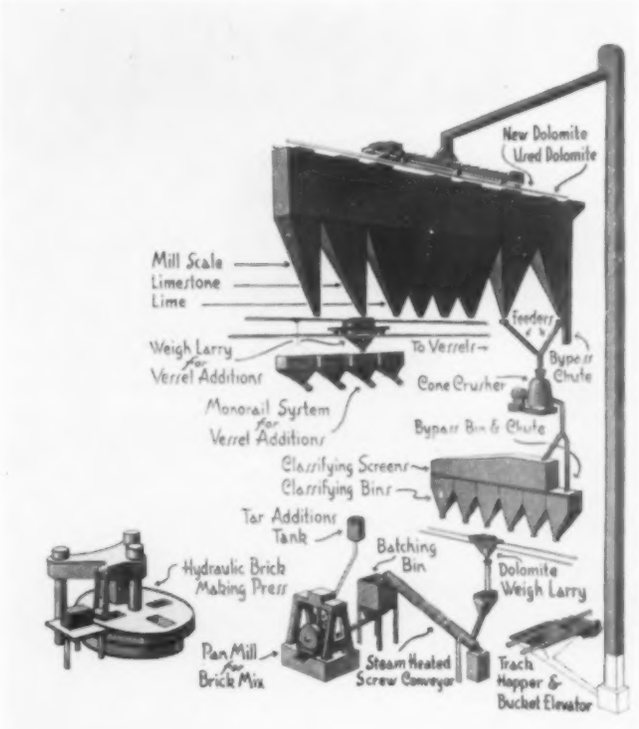
Liquid, rich in oxygen, flows from the bottom of the high pressure column to either one of the two adsorption type filters in order to remove any hydrocarbon which may have entered the unit. The liquid is then cooled by out-flowing nitrogen in a subcooler and released through a valve. It flows to the upper section of the low pressure column as a liquid feed.

Final separation takes place in the low pressure column which produces pure nitrogen gas at the top of the column and pure liquid oxygen at the bottom; the latter accumulates in the vaporizer to form a liquid bath around the tubes. In liquefying the nitrogen at the top of the high pressure column, as previously mentioned, this liquid oxygen is vaporized.

Oxygen gas is then withdrawn from the vaporizer and sent back through the liquefier and warm exchanger of the oxygen circuit. Pure nitrogen flowing from the top of the low pressure column serves to cool lean liquid and rich liquid in their respective subcoolers, and is then sent out of the plant through either one of the nitrogen regenerators.

The product oxygen gas, at slightly above atmos-

Figure 11 — The brick for the linings is made in the plant.



pheric pressure and at room temperature, may then be sent to a low pressure gas receiver, or compressed to any desired pressure in an oxygen compressor, according to the demands. Oxygen storage pressure is 25 atmospheres.

Other than for the usual mechanical delays and failures, the oxygen plant has been a success.

The tar-bonded dolomite brick used for the working lining of the vessels are made in the plant, the equipment being located near the vessels. The flow of materials (Figure 11) in this operation is as follows:

1. New dolomite and used dolomite are delivered to the same track hopper as serves the additions storage system.
2. Materials are next delivered to storage bins by elevator and a specially designed distributing conveyor system.
3. Next, dolomite is delivered to a ball mill, which has replaced a cone crusher originally installed.
4. Crushed dolomite is then delivered to a classifying screen and classifying bins.
5. The desired charge for the pan or pug mill is made up in a weigh larry, and then delivered to the mill through a steamheated screw type conveyor.
6. A tar addition is then made in the pan mill. The weight of an average charge is 2000 lb; time in mill per batch is 13 minutes.
7. The milled batch is delivered to a specially designed four-station automatic press which discharges a brick every thirty seconds. These bricks are 16 in. long and have an average cross-section of 7 in. sq. The average weight of one brick is 80 lb.

Oxygen jet steelmaking is particularly attractive for a number of reasons:

1. A minimum amount of equipment, such as cranes, buildings, charging cars, furnace equipment, controls, etc., is required in this shop.
2. Maintenance costs are usually in proportion to the equipment to be maintained; hence, mantenance costs are definitely less. This is particularly true of refractory costs; the pounds of refractories used in this process is less than 50 per cent of that used in the open hearth.
3. This type of steelmaking has all the operating conveniences and advantages of the bessemer shop. An open top vessel which can be tilted on trunnions for slagging off, charging, and tapping, is certainly most convenient for the operator.
4. Fewer operating personnel are required in the steelmaking section of the oxygen jet steel plant.
5. A lower production cost with a steel equal to, and for some purposes, superior to, open hearth quality.

In practically all applications oxygen jet steel is equal to open hearth steel and, in some special applications, is better than open hearth steel.

The nitrogen content of the finished steel is a function of the purity of the oxygen. With an oxygen purity of 99.5 per cent, nitrogen in the steel has been 0.0025 per cent or less; when the oxygen dropped to 99.2 per cent, the nitrogen content increased to 0.0035 per cent. Further, the oxygen content of this steel is definitely less than in the open hearth practice.

To date, all the low carbon rimmed and mechanically capped grades of steel for the hot and cold rolled strip mills have been made by this process, as well as skelp and other rimmed and killed grades for hot rolled plate and strip products up to 0.20 per cent carbon. Strip analyses average 0.06 to 0.10 per cent carbon, 0.030 to 0.040 per cent manganese, 0.025 per cent sulphur, and 0.015 per cent phosphorous.

AISE SPRING CONFERENCE

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LORD BALTIMORE HOTEL

BALTIMORE, MD.

PROTECTIVE DEVICES on Ore and Coal Bridges

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. . . . because humans are not perfect, protective devices are essential on items of equipment such as ore bridges to reduce the number of accidents which might otherwise take place . . . .

▲ MOST modern ore and coal bridges are similar to gantry cranes and require all the usual protective devices which apply to other electrically driven cranes. In addition they have characteristics which make it necessary to provide special protection. A brief description of a typical bridge will be given first to make it easier to understand the application of protective devices.

A bridge consists of a span supported on two legs each of which is supported by two motor driven trucks. The pier leg (Figure 1) looks like an inverted pyramid with one end of the span resting on skew plates on its four top corners. A vertical pin at the top center of the pier leg locks the span and leg together laterally but permits skewing. The other end of the span rests on a pivotable type of joint on the shear leg (Figure 2) which permits skewing of the span and also lean of the leg. The skewing occurs while the bridge is traveling, if one leg travels faster than the other. There is a tendency for one leg to travel faster than the other for several reasons. Fortunately, these reasons balance out in average operation so that the bridge does not have much tendency to skew. In some yards the bridge is skewed intentionally during regular operation due to certain peculiarities of operation.

A trolley (Figure 3) which runs on the span consists of a frame which carries two trolley travel engines, two hoist engines, a control house and an operator's cab. A bucket is suspended on ropes from the drums of the two hoist engines. The operator's cab is positioned under the trolley frame and usually under the control house with the front facing the bucket.

Some bridges have an apron which is a hinged cantilever to clear objects which may be in its path of travel such as ships masts when the bridge projects over a body of water to unload ships. This apron can be raised to clear the obstacle or lowered into working position.

Thus far the description does not include any protective features. A minimum of protection would be required if extreme care were exercised, but carefree operation requires numerous devices to protect personnel, equipment, and production. Ideal protection would eliminate all hazards, but since ideals are diffi-

Figure 1 — On the pier leg a vertical pin on the top of the leg permits skewing.

Figure 2 — The shear leg permits skewing and lean of the leg.

Figure 3 — On the bridge under discussion, the trolley is assumed to have two trolley engines, two hoist engines, a control house and the operator's cab.

cult or complicated, a compromise is in order. This compromise varies somewhat with the conditions and with the bridge owner's policy.

Some bridge operators dislike certain protective devices because these devices interfere with their methods of operation. With such unpopularity, these protective devices may be neglected, altered, or removed by maintenance personnel. Therefore, the bridge designers must keep all of these factors in mind when applying protective features to a bridge. Sometimes a compromise is required to appease the human element.

Protective devices which are more or less common to all motor controls as well as bridge equipment provide protection against short circuit, overload, undervoltage, field failure, overspeed, and bearing overtemperature. These are mostly magnetic or thermal relays of one type or another except the overspeed device. They are also applied directly to the control or rotating machinery.

Limit switches have an important part in the protection of bridges. All limit switches detect position or distance and transmit the information to some motor control, whereupon the control will act in a predetermined manner. In some instances the limit switch cooperates with other limit switches or other protective devices to perform a desired task of protection. Among the more common types are the hatchway type which is a control contact or contacts in an enclosure and operated by an external roller lever which returns to a normal position by a built-in spring when the lever is not held down. The track type is essentially the same as the hatchway except for the operating lever which is a V or U-shaped affair and it does not return to a normal position. It must be actuated in one direction and then in the other direction on the return cycle. The rotating cam limit switch has one or more cams on a shaft in an enclosure. The cams operate control contacts according to design. The end of the shaft protrudes through the enclosure for connection to a rotating machine or to a gear train to change the ratio between the driving mechanism and the cams. Step-up or step-down gears are used as required. A traveling nut limit switch consists of a long threaded shaft which carries a nut. The nut is in guides so that it will not turn as the shaft turns. A series of switch contacts are mounted on the stationary part of the enclosure along the shaft and they are operated by the traveling nut. The position of these contacts are adjustable. Other types of limit switches have been considered but rarely, if ever, used.

Other mechanical devices perform the function of limit switches. One example is the collector shoe for interlocking with a stationary object or another movable object. Still others provide more complicated protection than detecting position and distance such as the overspeed governor, the anemometer, and the wind directional vane. The first is self explanatory except that there are two types. The mechanical type is a centrifugal switch and the electrical is either an a-c or d-c generator used with relays which perform their duties at certain frequencies or voltage representing definite speeds.

All protective devices do not perform as limit switches. Simple things which are taken for granted, such as hand railing, kick plates, visual and audible signals, gear guards, plows or rail sweep, and last but not least the lowly safety support or jack which will keep a bridge or trolley from dropping too far if a wheel or axle should break, are also protective devices.

All of the discussion thus far is general, but coal and ore bridges have certain characteristics which require special protective devices as well as special application of some of the standard ones; so the remainder of the discussion will go into more detail on this subject.

BRIDGE TRAVEL

Bridge travel requires considerable protection. A bridge is subject to damage by overspeed due to wind. It is subject to damage by overskew due to unequal wind load on the two ends of the bridge, unequal friction load due to bearing wear or unequal lubrication, unequal loading due to trolley position on the span,

or unequal wheel diameters due to wear. It is subject to damage by collision with another bridge or other objects due to carelessness in operation or maintenance.

Rail clamps get prime consideration as a protective device to guard against damage by wind on coal and ore bridges. In conjunction with the anemometer, and in some cases with the wind directional vane, the rail clamps provide fully automatic protection against a wind velocity above 38 mphr.

Rail clamps are electrically released and are either gravity or spring applied. The author, being more familiar with the gravity type, will discuss this type in a little more detail. Figure 4 shows a typical rail clamp. The drive consists of a d-c mill motor, electrically applied and spring released brake, a reducer and a drum with wire rope. The other end of the rope is attached to the wedge shaped counterweight. The clamp consists of a supporting frame or tower which rests on its own track wheels to keep perfect alinement with the bridge runway rail. This tower is built into each sill of the bridge and it supports the clamp mechanism which consists of tong shaped jaws and the wedge shaped counterweight which operates the clamp. When the weight is raised, the jaws open to release the clamp and when it is lowered the wedge shape forces the tops of the clamp jaw levers apart, causing the jaws to grip the sides of the rail with great pressure. This pressure is obtained by mechanical advantage of the wedge, and the two simple levers which comprise the tong action of the clamp.

Rail clamps should not be used to stop the bridge in normal operation. Therefore, a time delay in setting is designed into them to permit the bridge to be stopped before the clamps are applied. Dynamic braking resistors are designed into the control circuit for the rail clamp motor which limits the lowering speed of the counterweight. This speed is adjusted at the time of installation for best performance.

When direct current is not available for driving the rail clamp engine, then conversion equipment is furnished or a special machine with a wound rotor motor and a permanent magnet d-c exciter for dynamic lowering is furnished.

Bridge users have been demanding more elaborate rail clamp protection against wind damage. Among those demands is faster than normal operation of the clamps in case of dangerous winds. Bridge builders recognize this and some have been developing improvements.

One such development has been tested in our shop. The holding power has been improved and the clamp can be quickly adjusted to set in any desired time from 2 to 10 or 15 seconds. The gravity system has been maintained but the operating mechanism is entirely new.

The anemometer equipment is a protective device which is constantly on guard against high winds. It records wind velocities, and stops bridge travel and sets the rail clamps in case of high wind velocity. It also turns off a green signal light; turns on a red one and sounds a siren. The equipment consists of an anemometer which is a wind driven permanent magnet

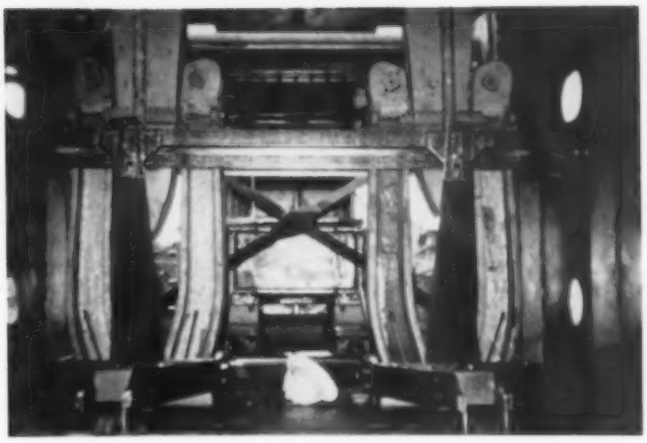

Figure 4 — Typical rail clamp shown is of the gravity type.

generator whose voltage is proportional to the wind velocity, a panel with a sensitive relay which picks up when the generated voltage reaches the value to which the relay is adjusted, and other contactors or relays which are controlled by the sensitive relay. The contactors or relays are then connected into the various circuits to perform the functions previously mentioned. The voltage from the anemometer is used also to move the pen on a recording voltmeter with the graph calibrated in miles per hour to record wind velocity. When two anemometers are used on the end of a bridge, either anemometer will stop the bridge and set the rail clamps if its wind velocity so dictates. Figure 5 shows an anemometer and wind directional vane.

A wind directional vane is a device used to modify the protection offered by the anemometer. As the name implies, it detects direction of the wind. This characteristic is used to permit the anemometer to stop bridge travel and apply rail clamps at two different wind velocities depending on the direction of wind with respect to the bridge. On one application the bridge is stopped at a wind velocity of 35 mphr within an angle of 135 degrees broadside to the bridge, but it is permitted to operate in a wind velocity up to 45 mphr within an angle of 45 degrees from either end of the bridge. The reason for this is obvious and needs no explanation here. The selectivity is obtained by a voltage dropping resistor in the sensitive relay coil circuit. This resistor is in the circuit for the 45 mphr wind and it is shorted out by contacts on slip rings

Figure 5 — Anemometers are used on the bridge to stop operation when the wind exceeds predetermined velocities.

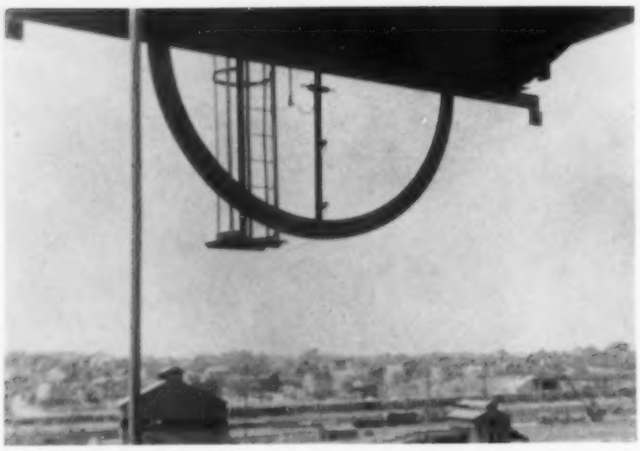

Figure 6 — Skew indicator tells the operators how much his bridge is skewed.

on the shaft of the directional vane for operation at 35 mphr.

When a bridge is traveling in the same direction as the wind, the speed may become excessive, so some bridges have overspeed governors connected to the bridge drive mechanism. These governors operate contacts at a predetermined speed which initiate the automatic slowdown by the magnetic control. Control manufacturers have different schemes all of which are effective to reduce the speed electrically.

Skew has been mentioned previously, but overskew is possible so it is necessary for the operator to know if his bridge is skewed.

A skew indicator (Figure 6) tells the operator the degree and direction that the bridge is skewed. He can either square up the bridge or skew it intentionally by driving only one leg, and the skew indicator tells him what he is doing. It does not control the bridge in any way but only indicates its position.

The indicator is located at one end of the span usually where the operator faces it when he is at the controls. It consists of an 8 to 10-ft semicircular dial and a pointer which points down to the middle of the dial when the bridge is not skewed. The dial is marked at positions around the arc to represent the calculated positions of first slowdown, the second slowdown, and final stop in each direction of skew. The pointer is made of flat steel about four inches wide and on it there are two 100-watt lamps, one above the other for visibility at night. The lamps are carried by the pointer so that when they are one above the other in a vertical line, the bridge is square. An angle either to the left or to the right indicates skew in that direction. The pointer is operated by two ¼-in. plow steel galvanized tiller ropes. One end of each rope is attached to the pointer and the other ends are attached to opposite sides of the leg nearest to that end of the bridge. As the bridge is skewed, one rope pulls the pointer while the other follows to give indication in the proper direction.

Skew indication is all the automatic protection against overskew that would be required if we wanted to burden the operator with the full responsibility of keeping the bridge from overskewing. But his skill and stamina are required for other duties, so automatic skew protection was developed. First attempts at protection against overskew consisted of opening a control circuit by means of slip ring and contact finger or a single hatchway limit switch when the bridge approached a dangerous skew. Later two or more hatchway limit switches were employed to give directional selectivity so that the bridge could be squared by the operator without help from another person.

Modern bridges have much more elaborate control schemes to prevent overskew. Two ten-cam control skew limit switches are used. One limit switch with more cams could be applied but two are used to reduce the amount of control wiring across the span. Each limit switch is associated with the control for the leg on which it is mounted. A three to one increasing gear ratio is connected to each to obtain maximum sensitivity from the cam-operated switches. Each limit switch is equipped with a special lever with a slot in it, mounted on the shaft. The actuator is mounted on the span in such a manner that a pin engages the slot on the arm so that when the bridge is skewed in one direction, the limit switch shaft will be rotated in the clockwise direction and if the bridge is skewed in the other direction, the limit switch shaft will be rotated counter clockwise.

There are three steps of automatic control by these skew limit switches. When the bridge is traveling and becomes skewed approximately 1 in 33 (which means that the leading leg is ahead of the lagging leg by an amount equal to one foot for each 33 ft of length of the span between the legs) each of the two skew limit switches operates its first contact which in turn produces the first slowdown of the leading leg to a value of approximately 50 per cent of full load speed.

If the bridge skews still more in the same direction until the skew reaches a value of approximately 1 in 28, both cam limit switches open their second contact which produces the second slowdown of the leading leg to a value of about 20 per cent of full load speed.

Still further skewing of the bridge to a degree of about one in 24, causes both skew limit switches to open their third contact which produces the final stop by control skew limit switch. This is equivalent to mov-

Figure 7 — Skew limit switches are set to allow only a predetermined amount of skew.

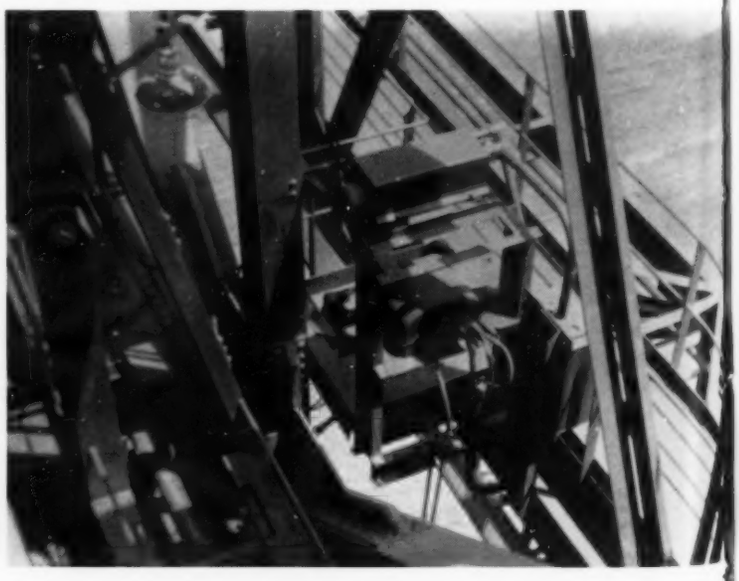

Figure 8 — Buffers are used on bridges to reduce impact and help clear track.

ing the master switch to the off point for the leading leg, which takes power off the motors and sets the brakes. On some bridges this point also sets the rail clamp. A fourth cam had been used to open another contact in series with the one at this point of skew to back up the first one, but this practice has been discontinued since power skew limit switches have been added as will be explained a little later.

The above three points of control by skew limit switch are selective and directional. In other words, only the leading leg is affected in the direction that the bridge is traveling while it is skewed. If the bridge were stopped while it is skewed and started in the other direction, then the opposite leg becomes the leading leg and its limit switch is already set for the slowdown so it would not accelerate to full speed until the first leg catches up with it to the point where the limit switches close their contacts. Figure 7 shows a control skew limit switch and a power skew limit switch installation.

Two power skew limit switches are applied to back up the control skew limit switches. Overhoist type power limit switches are specially applied and one is mounted on each leg at span level to avoid expensive wiring across the span. Their operating mechanism is designed to trip the switch at a skew of about 1 in 20, and to open both sides of the power circuit which feeds the bridge travel control panel for that leg. This is the same as power failure; so the motors stop, brakes set, and rail clamps are applied. To reset these it is necessary for the operator to call for help. The limit switches are held manually while the operator brings the bridge back toward square until the tripping mechanism can be reset.

A bridge could get in trouble otherwise than by overskewing or overspeeding. It could collide with another bridge on the same track or with other objects on an adjacent track. Where such conditions exist, special protective devices are required. For bridges on the same runway a buffer of the railroad freight car draft gear type (Figure 8) is applied at the end of the trucks or equalizer. Each bridge would have one such assembly at each corner so that these would come together on the two bridges to lessen the shock of collision. This implies that the bridges should be decelerated and stopped by the operator rather than stopped by collision. This might raise a question "Why does not someone design a safety device to stop the bridge or reduce the speed automatically before collision?" The answer is that it has been done but the application is not in great demand because such collisions are rare due to slow travel of the bridge, and the operator is not surprised by lack of time to stop.

The one example of application of such protection with which the writer is familiar is on unloading towers rather than bridges, but the tower travel would be similar to bridge travel. These towers are equipped with four roller lever or hatchway type limit switches in the tower travel circuit to stop the travel. The actuator is a built up hinged lever with a four foot wide sweep at the outer end and counterweight at the other end. The sweep is about 18 inches above the track and projects out ahead of the tower far enough so that when it reaches an obstruction the tower will stop before the bumper reaches the obstruction on the track. The sweep swings back to actuate the limit switch then continues to swing back without damage until the tower stops. In this example the tower travel speed is very low so that the lever was designed to swing only three feet. Once the tower is stopped it cannot restart in the same direction until the lever is released, but it is free to travel in the opposite direction.

The writer knows of a need for at least one more application of anti-collision devices. In this case a bridge runway and a tower runway are parallel. The bridge is higher and one of its cantilevers passes over the tower when they pass each other. If the trolley were on this cantilever there would be a collision between the trolley and the tower; so an interlocking scheme is necessary. It was proposed to have one collector shoe on the bridge make contact with a contact conductor on the tower which completes the circuit for tripping the main circuit breakers on both machines. This circuit is further designed so that the bridge operator can hold his hand on the closing push-button for his main circuit breaker which permits him to move his trolley until it is off the cantilever into the safe zone. Then he is free to run the bridge travel to get away from the tower. This scheme requires three additional sliding contacts on the trolley runway. In other words, the sliding contacts between the tower and bridge are used as a protective device.

TROLLEY

Modern high speed trolleys have special protective features. Speed control has become of greater importance as the demands for production increased. Operating time cycles are shortened by increasing trolley speeds and by approaching closer to the working zones before slowing down. A slight human error might cause a serious accident which would damage equipment or injure the operator; so automatic control in the end zones was developed. The ultimate goal is to slowdown and stop the trolley safely by automatic means if the operator is not alert or if he loses control for some other reason.

There are two trolley speed control zones at each end of the span. In the middle of the span the operator is at liberty to operate the trolley at full speed. When the trolley reaches the first slowdown position at either end of the span, a high speed track type limit switch is actuated. If the trolley speed is lower than a predetermined safe value, the trolley continues to run in the same direction under full control of the operator. When the trolley reaches the second slowdown position at either end of the span, a second track type limit switch is actuated. If the speed is now lower than a predetermined safe value for that zone, the trolley still continues to run under full control of the operator.

Now starting back at the middle of the span and again reaching the first slowdown zone where the first limit switch is actuated, but this time at a speed higher than the predetermined safe value, the trolley is automatically slowed down and stopped. The first slowdown limit switch is the protective device which started the action but the speed measuring device had a hand in it too. These two together take control away from the careless operator and stop the trolley. If this first slowdown zone was entered at a safe speed and the trolley reached the second slowdown zone at a speed higher than the predetermined safe value, then another position limit switch and speed measuring device take control and stop the trolley the same as described above. Assuming that the trolley has passed both slowdown zones at safe speeds, it is possible to run into the buffers just under the speed limit for the final stop zone. Of course, this is not a normal operating condition, but it is not dangerous to life or property because of the protective device just mentioned—the trolley buffers.

Trolley buffers are of three general types, the spring type, the friction type, and the hydraulic type. The hydraulic types (Figure 9) are designed to take the impact of the trolley traveling at full speed. In addition, the orifice must be automatically variable so that the deceleration is constant and the trolley will come to a stop just before the buffer is fully compressed. In contacting the buffers, the trolley latches on to them so that they will be automatically reset when the trolley backs away. The hooks release when the buffers are fully extended or reset. There are two buffers at each end of the bridge applied in such a manner that one pair is used to stop the trolley traveling in the forward direction and the other pair is used to stop the trolley traveling in the reverse direction. Buffers are applied for emergency use only and are not intended for stopping in normal operation. With the automatic slowdowns functioning as described previously, it is impossible to run into the buffers at full speed.

Spring type buffers are not designed for smooth deceleration of the trolley from full speed. They are, however, designed to stop the trolley without damage from a speed of about one-third of full rated speed.

Sanders are used as a protective device on trolleys to give better traction when emergency stops are necessary. Sand is automatically applied ahead of the trolley wheels when it is stopped by slowdown limit switches in the end zones. The sanders are interlocked with the control so that sand runs only while the trolley is in motion so that sand would not be wasted. However, the operator can apply sand at any time by depressing a foot switch in the operator's cab. This can be done at intervals during a rain or snow storm to prevent sliding the wheels in normal operation.

Figure 9 — Hydraulic trolley bumpers are designed to absorb impact of unit traveling at full speed.

APRON HOIST

Aprons on bridges require limit switch and brake protection. They have slowdown and stop control type limit switches in each direction. Usually these are cam type or traveling nut type driven by a suitable connection to the engine. In addition there is a hatchway limit switch which serves as a final up stop, a slack cable limit switch which stops the lowering motion, when the apron is engaged in a safety hook when it is in the raised position. The normal up stop is bypassed by a pushbutton in raising the apron to release it from the hook just prior to lowering the apron, then the final stop protects against overhoisting. Some bridges have a power type overhoist limit switch to back up the control switch just mentioned.

BUCKET HOIST

The bucket hoist is protected by an overhoist limit switch which is operated by levers or a chain which serves as a weight. When the lever or weight is raised by contact with the bucket in the raised position, the limit switch is actuated which acts on the hoist control to stop the bucket. The limit switch is usually a coun-

terweighted type.Sometimes the power type is used but it is applied in the control circuit. When a down limit is desired then a cam limit switch or a traveling nut is required. A down limit is used to prevent digging dirt in the ore or coal yard when the pile is low. It also prevents running all the rope off the hoist drums which may cause some damage.

HOPPER GATE

Electrically operated hopper gates have either a cam limit switch or two hatchway limit switches for stopping the gate drive at fully open or fully closed positions. These are generally used in regular operation rather than as protective devices only.

STANDARDIZATION

Standardization of details of application of protective devices on ore and coal bridges is not practical because there is no volume production of bridges. Sometimes a rigid specification on the part of the purchaser cramps the style of the designer. This is especially true in the proposal stage where competitive bidding is based on the purchasers specifications. For the same reason this presentation may suggest considerable discussion.

SUMMARY

In conclusion it may be said that this discussion is intended to bring to attention the need for protective devices on coal and ore bridges and to explain some special ones so that their function would be better understood. Need is related to past experience and one user's bad experience may affect future designs of many bridges. Human inefficiency creates these needs. If all operators and maintenance personnel were 100 per cent efficient the need for protective devices would not have been developed so extensively. To err is human, so we need more and better protective devices as time goes by.

DISCUSSION

PRESENTED BY

G. F. SHUMAKER, JR., Electric Control Engineer, Bethlehem Steel Co., Johnstown, Pa.

C. B. RISLER, Material Handling Industry Engineer, Industrial Engineering Div., Westinghouse Electric Corp., East Pittsburgh, Pa.

S. R. RIFKIN, Application Engineer, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

B. H. CARLISLE, Electrical Engineer, The Clark Controller Co., Cleveland, Ohio.

L. A. KOENIG, Commercial Engineering Dept., The Clark Controller Co., Cleveland, Ohio.

A. H. MYLES, Assistant Chief Engineer, Electric Controller and Manufacturing Co., Cleveland, Ohio.

S. TATALOVICH, Electrical Engineer, Heyl and Patterson, Inc., Pittsburgh, Pa.

G. F. Shumaker, Jr.: The Johnstown plant of Bethlehem Steel Co. recently put into operation a 15-ton ore bridge. My comments will cover some of the experiences with the safety devices on this bridge.

The bridge drive is powered with six 35-hp compound motors using shunt brakes. Four motors are used to drive the pier leg and two to drive the shear leg. The drive is controlled from the trolley cab while the control panels are mounted on the respective legs. This drive has the standard undervoltage, over-load and field-loss protection, and in addition to this it has anemometer and skew protection. The drive has off-position dynamic braking, but no loss-power dynamic braking. However, the shunt brakes set with loss of power, providing protection in case of power failure.

Two voltage sensitive relays, on one anemometer generator provide two degrees of wind protection. When the wind velocity reaches 32 mphr, a signal light changes from green to red in the operator cab. If the operator should then try to raise the rail clamps, the siren is sounded. The reason the siren sounds only when the operator tries to raise the rail clamps is that the ore yard is located on the edge of a borough and the siren disturbs the neighborhood and creates confusion with the borough fire department. At this wind velocity the operator can traverse the bridge, but has ample warning with both lights and siren that the wind is becoming critical. When the wind attains a velocity of 38 mphr the second voltage sensitive relay disconnects all power from the bridge and the following events take place:

The bridge is first slowed down by dynamic braking; second the brakes are set with time delay; and third, the gravity-type rail clamps are set. All of these operations are done automatically.

The skew protection consists of two power limit switches and two 3-point control limit switches. One of each is located on both ends of the bridge. These switches function identically to those described in Mr. Tatalovich's paper. The operator has visual skew information from a skew indicator that has also been described.

The trolley of the bridge is powered with two 200-hp series motors using shunt brakes. Located on both ends of the bridge are two spring loaded buffers capable of bringing the trolley to rest, provided its velocity is not greater than 25 per cent of rated speed.

The high and low-speed governors are set at 525 and 275 fpm, respectively. These settings furnish adequate protection to the trolley and at the same time do not interfere seriously with its operation.

When the bridge was first put into operation, some difficulty was experienced in getting the trolley out of the speed zones. The control was originally interlocked so that plugging to the third point by-passed both the zone switches and over-speed governors. The difficulty in getting out of the speed zone arose because the trolley would accelerate past the setting of the high-speed governor within the speed zone on the second and third points of control. This, of course, set up a loss power dynamic braking circuit, set the brakes, and brought the trolley to rest. The problem was solved by using a polarized relay to by-pass the governor contacts. This lets the operator leave the speed zone at any desired velocity, which provides him with greater freedom of control.

The trolley dynamic-braking circuit uses three definite time steps. I believe that the distance required to stop the trolley could be considerably shortened if the dynamic-braking steps were controlled by a function of speed rather than a function of time. This improvement would then allow the speed zones to be shortened, thus providing more safe high-speed space on the bridge.

The holding line and closing line drives are powered by 265-hp series motors using shunt brakes. Two crane power limit switches are used in the control circuit as final stops to furnish over-travel protection in the hoist direction only.

Safety devices should be carefully checked and maintained if they are to perform properly. The operators are instructed to check the various limit switches at the beginning of each turn. An inspection committee, composed of representatives from the electrical, blast furnace, engineering, safety, and mechanical departments make regular monthly inspections of all ore bridges. During these inspections, all safety devices are actuated deliberately to see that they are all performing properly.

Member: I would like to enlarge somewhat on one of the points made by Mr. Tatalovich and also commented upon by the gentleman from the Johnstown plant of Bethlehem Steel. This will discuss the functioning of the trolley in the end zone of the bridge. The speed switches are set. The high-speed switches are set at one speed, and the low-speed switches are set at another speed. The location of the limit switch tripping devices is determined from the speed setting of the low-speed governor.

This is somewhat arbitrary, depending upon the manufacturer's or the machine's ability to withstand direct impact upon the bumper, because by bringing the trolley into the end zone at a low speed under this governor it is possible to hit the bumper.

It is possible to provide braking torque on the trolley which will, when actuated at the proper point and at the proper speed, stop the trolley just at the bumper without striking the end. By using the two limit switches and the two speed governors, we lose a lot of valuable space in the operation in the end zone, because in order to avoid a tripping, or the establishment of the dynamic braking circuit, we must get under these governors at these points. Consequently a full stop must be initiated earlier. Consequently you lose the available high speed running distance indicator.

Recently we have had more and more need to operate at high speeds in the end zones. It is brought about by sometimes the peculiar arrangement of the ore dock. Mr. Tatalovich mentioned in one instance where the bridge overhung the unloading tower and that meant that the unloading tower was required to get clear back into the end in order to drop the ore back near a wall, and the bridge then had to come up to the end of its span in order to pick that ore up.

So it is a requirement that we must work into the end zone, and we do lose this amount of span travel.

One solution to this would be to increase the number of limit switches and speed governors.

It is apparent that the ideal number to reduce dead travel space to a minimum would be an infinite number all along this line. That is not feasible, but I think that is the ultimate solution.

One thing that gets us into this particular trouble is the fact that the braking torque that we can apply is frequently less than the plugging torque. One of the considerations that leads to that determination is the wet weather condition, and the case that perhaps there would be no sand in the sanders. There has been a great amount of discussion and guesswork as to the coefficient of traction that might be expected, and if we provide a braking torque which will definitely function without wheel slip for the lowest possible coefficient of adhesion, then the plugging torque, of course, can be considerably higher than that, assuming a dry and sunny day.

I believe it is possible to make a device—and we are now engaged in making such device and hope to test it in the near future—which will permit a measurement of speed throughout the whole range from maximum speed to zero speed, and which, used in conjunction with one limit switch located at this further point, will in effect be in infinite number of limit switches. At any stage it will provide an indication of the distance you can wait after tripping the one limit switch.

We propose to do that by using a voltage which will be a measurement of speed and using that voltage to determine the time delay on a relay which will drop out at any time, the time being precisely determined after the limit switch is tripped so that at maximum speed the time delay will be zero and at zero speed the time delay will be infinite.

C. B. Risler: The author mentions protection against overload, undervoltage, over-speed and bearing overtemperature on rotating equipment. We have found on adjustable voltage ore bridges where the power conversion source is a large motor-generator set, that valuable time can be saved in locating trouble by the use of an annunciator box located in the main machinery house. To arrive in a machinery room and find a motor-generator set gradually coasting to a stop, but with no apparent reason for it having dropped off the line leaves one with little clue as to the immediate steps to take in remedying the difficulty.

The annunciator has individual flags for the several bearing temperature relays, undervoltage relay, overload relay and over-speed tripping device. Thus if any of these devices should cause the main motor-generator set to be removed from the line, the operator, when he goes in the machinery house, receives an immediate clue to the trouble and thus save many minutes in getting the equipment back on the line. Such minutes are extremely valuable, particularly when the bridge is being used to unload vessels and which must be turned around and gotten back to sea.

In a discussion of limit switches and their functional use the manner of their connection in the electrical circuits is significant. Again this is to a large degree the matter of individual customer preference or safety practice as to whether the limit switches are of a single or two-circuit type, and are connected to interrupt one side or both sides of the control line. The major factor influencing this decision is the relative frequency and

severity of grounds which can cause malfunction of the control circuits and possible unsafe conditions if both sides of the line are not interrupted.

A protective device not mentioned by Mr. Tatalovich, but so common as to perhaps be taken for granted, is the use of the "off" position reset on master switches. This feature in control circuitry requires that the master switches be placed in the "off" position upon return of energy before the drive can operate. It protects against the operator leaving a master switch in a running position in case of power failure or shutdown, and upon return of power finding the motion operating and in trouble. This thought also leads to the consideration of spring return master switches which also prevent this. However spring return masters are not popular with operators who are forced to work on a high production cycle since they require that the operator must not only oppose the spring force at all times, but must actually hold the master switch in the running position and thus can only operate two drives at any one time.

A further protective device is the design into adjustable voltage circuits of current limit equipment which will definitely limit the torque exerted by any drive. Such current limit can prevent hoisting of overloads i.e., if the bucket should become caught in a hatchway or should one of the two motors on a bucket hoist be inoperable and an attempt made to hoist the entire bucket on the remaining motor. Such protection not only serves in the obvious cases indicated above, but also by continually reducing the stresses supplied to the mechanical equipment reduces the fatigue element and thereby considerably lengthens the life or increases the safety factor maintained during a given life expectancy.

I believe attention should be directed also to the very universal requirement that the operator has within his reach at his operator's station some means of positively disconnecting from the line all of those motions under his control. This can either by done by locating a circuit breaker or safety switch within his reach or by having a pushbutton available which can operate a shunt trip or low voltage circuit to cause such an interruption of power.

S. Rifkin: Mr. Tatalovich has covered his subject quite thoroughly, and I hope that his paper will result in comments from bridge users as to whether some protective devices should be eliminated or others added. After all, the bridge builders and the electrical manufacturers are only trying to make the equipment as safe as possible, based on both theory and past experience, but it is foolish to "clutter up" panels and diagrams with devices that will be made inoperative by the maintenance personnel after the bridge has been placed in service.

There are a few other protective features that were not mentioned by Mr. Tatalovich; although, in a way, they might be considered as overload or field loss devices on d-c constant-potential bridges. One is the jam relay, that is normally included in the closing line control to limit the maximum stalled torque of the closing line motor when the bucket jaws are closed, and also to prevent lifting the loaded bucket by pulling in on the closing line only. Another is the brake operating relay that is provided on most large bridges. On the hoist motion of d-c cranes, it is customary, of course, to use series wound brakes with coils connected in the motor series field circuit. That practice is followed in order to prevent releasing the brake if there is no current flowing in the motor series field circuit. However the holding and closing line motions of most large bridges require the maximum available size of magnetic brake, and series coils are not available for that size brake. Consequently, brake operating relays, with coils connected in the motor series field circuit are provided on the control panels, and the relays must pick up to show that there is current in the series field before the brakes are energized. The same relays are provided on adjustable-voltage bridges to insure that the circuit between the generator armature and the motor armature has not been interrupted.

B. H. Carlisle and **L. A. Koenig:** There is, however, one point which we believe deserves to be emphasized. Many protective devices do not function during normal operation of the bridge, and may not be called upon to operate for long periods of time. However, when they are called upon to operate, there should be reasonable assurance that the protective devices will operate and operate properly.

This fact is held in mind in the design and application of electrical protective devices. For example, relay contacts which may carry current for long periods of time without operating are often constructed of a non-weld type of material. Also, circuits are designed so that limit switches and similar protective devices perform the desired operation with a minimum number of intermediate relays. Where intermediate relays are required, the circuit is made as fail-safe as possible. By "fail-safe" we mean that failure of any of the main parts of the intermediate device will cause the equipment to shut down.

The reliability of protective devices on ore and coal bridges is important and deserves serious consideration.

A. H. Myles: In connection with the travel drive where all control is from the operator's cab, we have always stressed the safety and protection provided by bringing the power to the travel drive through disconnecting contactors in the cab. This arrangement provides direct control by the operator in case of emergency or fault.

With regard to protective equipment, the rail clamps are obviously of great importance. There has been much discussion on how to test and adjust the clamps. The question of time delay in setting the clamps has also been discussed. Would the author care to recommend a test procedure in the field and a proper setting time? I am also wondering whether it has ever been considered desirable to provide a shorter setting time when the anemometer equipment trips than under normal operating conditions.

The discussion of the trolley end zone control by Mr. Tatalovich was of particular interest since we had early experience with the all-electric end zone control system referred to. Our first installation had two end zone speed ranges for each direction of trolley travel, and

provided for removal of power, setting of the brakes, and application of the sanders if either zone was entered at a speed higher than the setting of the protective control equipment. The speed sensitive equipment consisted of frequency responsive relays obtaining their power from a small alternator directly coupled to the trolley motors. More recently we have also supplied trolley control using two centrifugal switches coupled directly to the trolley drive and set to operate in accordance with the end zone speed limitations. On later installations we have applied graduated dynamic braking to the trolley motors if the end zones were entered at too high a speed. The motor brakes are held released by a voltage relay connected across the dynamic braking resistance until dynamic braking has materially reduced the trolley speed, after which the brakes set.

S. Tatalovich: Mr. Shumaker said there are six motors, where I said four. That is a matter of detail, where I just took a typical bridge. Some bridges have more than six motors. He talked about another detail, two voltage sensitive relays on one anemometer, which is, of course, another detail. We know about that.

As far as the siren is concerned, not stopping traffic in town, maybe if there is a big wind we ought to stop the traffic and make the people get inside. If the city ordinance does not allow that, we can put on a different type of alarm which does not interfere with the fire department.

The next point was about limit switches, which was also brought out by a discusser. I fully agree that they can reduce the stopping distance by elaborating more on the type of speed control, dependent on speed rather than time, and I think the gentlemen have been studying a common problem there, and if they find a solution they will help us all.

Mr. Risler suggests annunciators for helping the maintenance personnel in locating fault. That is very true. When a motor-generator set is rolling to a stop and the maintenance man comes there, he does not know what the trouble is. With an annunciator system he can pinpoint the fault very quickly. Whether or not the extra cost is justified can only be determined by the purchaser.

Another point he brings up is about two-circuit type limit switches. A lot of users want both sides of the line broken, and there are arguments for and against that. The argument against it is that you have more wiring, it is a little more expensive to install in the first place, and you have more wiring that might go bad.

Mr. Risler suggested that we should mention current limit to prevent an unloader from attempting to hoist the whole load or to prevent the bucket from attempting to lift the ship or whatever may catch onto the bucket.

Mr. Rifkin has brought out the use of a jam relay which would serve the same purpose on a constant voltage.

Back to Mr. Risler's comment, the means of disconnecting that was taken for granted and not even brought out in our paper. I want to thank you for bringing it out.

Mr. Koenig brought out the point that some protective devices do not operate for a long time, and they should be checked and properly maintained and possibly tested frequently at certain intervals. This was mentioned in the paper but it can stand repetition many times since it is that proverbial "ounce of prevention."

Mr. Myles has briefly reviewed the development of trolley speed control in the end zones—their first type to their latest scheme. This shows the importance of trolley protection since new and better schemes are being developed as the demand for production increases.

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

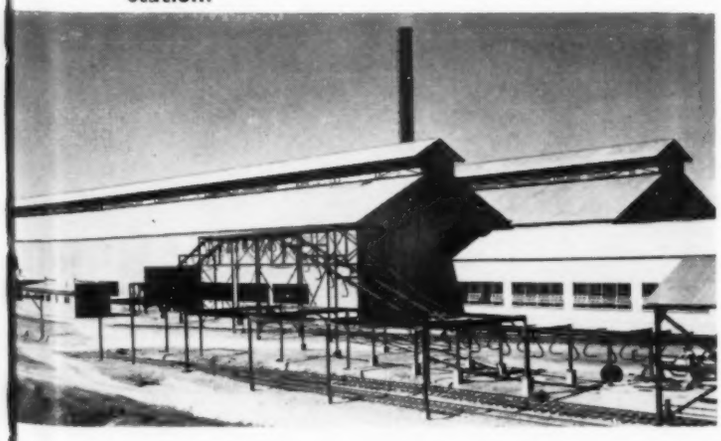
Colorado Fuel and Iron's 3-Strand High Speed Rod Mill

By V. W. JOHNSON
Superintendent of Rolling Mills and Finishing
The Colorado Fuel and Iron Corp.
Pueblo, Colo.

. . . . this 3-strand high speed rod mill is unique in that it rolls No. 5 rod mostly from 4⅜-in. billets . . . . in spite of this handicap, mill has set a number of unusual production records . . . .

▲ ON August 29, 1949, The Colorado Fuel and Iron Corp. at its Minnequa Works, Pueblo, Colo., put into operation their new three-strand, high-speed continuous rod mill. This new mill replaced the old hand-looping 18-stand Garrett rod mill which had been in continuous operation since March, 1903. At that time, the rod mill, built to furnish rods for the Pueblo Plant wire mills, was the only one in the western part of our United States. For nearly half a century this installation played a very important part in supplying the various wire products necessary in the building and expansion of the west. The mill produced nearly four million tons over these years, most of which was used in the western part of the country.

Figure 1 — The new rod mill has approximately 87,500 square feet under roof. The main building is 475 ft long by 90 ft wide, and the roll shop building to right is 112 ft long by 40 ft wide. The foreground shows the hook conveyor coming out of the main building, up over a railroad track and down to the unloading station.



With the introduction of continuous wire drawing machines making several reductions simultaneously at high speeds, and the expanding number of end uses for drawn wire products, the quality of hot-rolled rod demanded by these modern wire mills increased many-fold. To meet these demands close section tolerances are a must as are rod surfaces free of seams, laps, and rolled-in scale. Rods with chemistry ranges from 0.05 to 0.95 per cent carbon and from 0.10 to 1.50 per cent manganese in either rimmed, semi-killed or killed steels are tailored to suit the metallurgical requirements of the varied end products. Maximum bundle weights are of course a must for economic drawing-room operation.

The new rod mill is a complete installation featuring the most recent ideas in engineering and construction. All the latest known methods for producing high quality rods at high speeds in coil weights up to approximately 700 pounds are incorporated in the design. There are many rod mills in this country, as well as abroad, which are theoretically much alike, and yet none, so far as can be ascertained, are identical. They differ in many ways—number of roll stands and their arrangements; size and speeds of rolls; pass design and reductions per pass; type of roll bearings; types and variations of guides and other roll furniture; coil weight, etc. It is not therefore unusual for this paper to describe an installation that is different.

As there is no conventional billet mill in the Minnequa Plant, nor any mill on which 2½-in. billets could be produced economically, it was necessary to design an installation that would produce a $\frac{7}{32}$-in. rod from a 4⅜-in. billet. Billets are rolled on the rail mill which has excellent facilities and considerable idle time due to insufficient rail orders and can supply billets for all rod mill requirements. The above statement—a $\frac{7}{32}$-in.

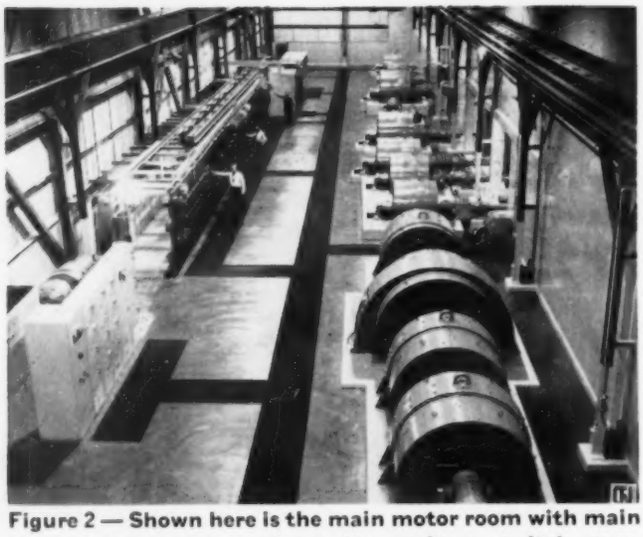


Figure 2 — Shown here is the main motor room with main motor-generator set, motor exciters, switch gear, panel control board and the eight motors that drive roll stands 0 to 13 inclusive.

rod is rolled from a 4⅜-in. billet with almost 19 sq in. of area—may be confusing when today 7/32-in. rods are seldom rolled from billets larger than 2½ in., or about 6¼ sq in. of area. For these reasons the mill being described is unique.

The main mill building is 475 ft long and 90 ft wide. In it there is a heating furnace, a 4-stand billet mill, a roller table 75 ft long, and up-and-down-cut shear, another roller table 50 ft long, a holding or heat restoring furnace and a conventional 23-stand contin-

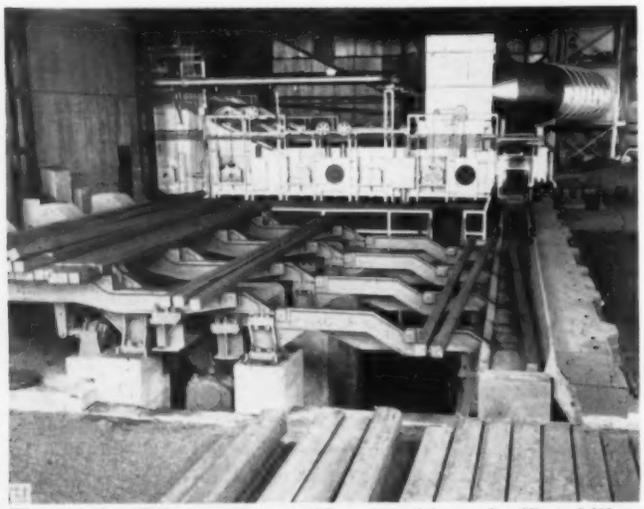


Figure 3 — Billet unscrambler machine shuffles billets down the four stages. Final single row on the bottom stage is ready to move on to the furnace roller line.

uous rod mill with normal accessories. In fact, this installation can be classified as two mills operating simultaneously as one mill—a unique design which has been the subject of much publicity, discussion and interest.

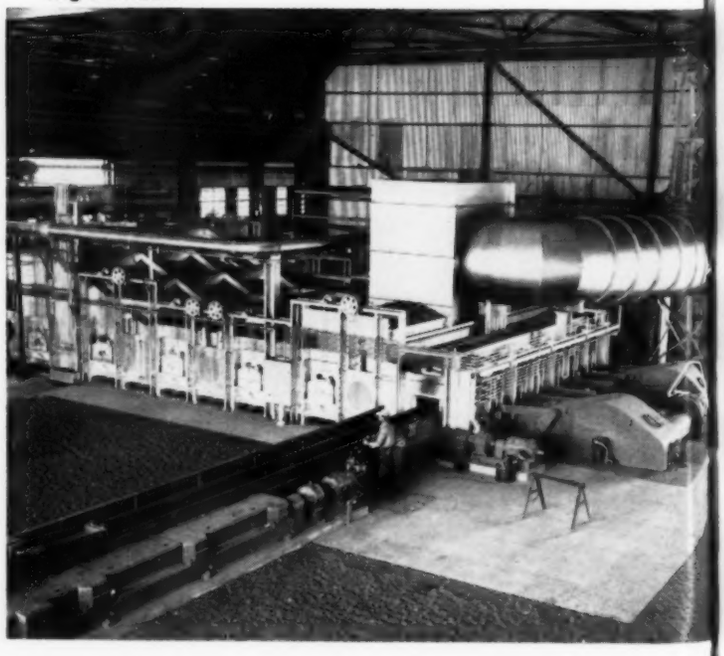
The 4⅜-in. billets previously mentioned are produced at the rail mill from approximately 5-ton ingots. Ingots are heated in modern soaking pits with automatic controls for pit pressure, gas and air ratio, and temperature. Twenty-one passes are used in the 36-in. blooming mill, five passes in the 29-in. roughing mill, two passes in the 28-in. intermediate mill, and one pass in the 26-in. finishing mill—a total of 29 passes to reduce the 24-in. by 24 in. ingot to a 4⅜-in. sq billet. Billets are sawed to lengths weighing from 1250 to 1445 pounds each and are stamped on the end with the heat number and grade.

From the rail mill cooling beds an overhead magnet crane moves the billets to either the rail mill billet storage yard which has a capacity of 10,000 tons or loads them in special-built standard gage railroad cars for transportation to the rod mill billet yard. This billet yard is equipped with a 15-ton overhead double magnet crane and billet storage racks in which billets are separated by heat number and grade. The yard has a capacity of about 8000 tons. Billets are unloaded from cars in 9 to 10-ton lifts and placed either in the storage racks or directly onto the 50-ton unscrambling bed. With the unscrambling bed loaded to capacity, the crane has almost one hour of available time for unloading cars into billet stock.

The billet unscrambler is a machine with a series of walking or shuttle bars that arrange the billets for placement, one at a time, onto the furnace charging roller table. On the charging table there is an electrically operated traveling pusher arm for pushing the billets into a sidecharge continuous heating furnace. All the unscrambling, charging and pushing equipment is under the control of the furnace charger.

The billet heating furnace has a rated capacity of 60 tons per hour and is of the side-charge, side-discharge design. It has a level hearth 69 ft-8½ in. long by 26 ft wide, and is divided into two zones by a choke or knuckle formed in the suspended roof. The soaking zone consists of 23.5 per cent of the effective heating area of the hearth; the preheating and heating zone 76.5 per cent. With a normal charge of 4⅜-in. billets, the furnace contains 170 billets; enough for slightly more than two hours of operation. About 28 to 30

Figure 4 — Close up of pusher mechanism shows controls for operating the billet unscrambler, roller line, billet pusher in the roller line and the six motor driven pusher arms for charging into the 60-ton billet heating furnace.



minutes of this time is spent in the soaking zone. At the highest rate of operation, a temperature differential between the surface temperature of the steel and the furnace indicated temperature of 20 to 30 F exists in the soaking zone, and as high as 40 to 60 F in the heating zone. This differential becomes smaller at production rates below 50 tons per hour.

The furnace is top fired with a separate set of burners for each zone and uses either coke-oven or natural gas. It is fully equipped with automatic controls to regulate the gas, air pressures and temperatures. Safety controls to shut off the gas valves in the event of failure of gas, air or electric power are another feature.

At the front end of the furnace, on signal from the mill feeder billets are discharged through the side door of the furnace by a water-cooled pusher bar driven by a set of pinch rollers controlled by the pusher operator. The billets then enter the continuous breakdown or billet mill consisting of four 18-in. roll stands driven through gear sets by a 2000-hp a-c motor. This mill is equipped with mechanical roller twisters between each stand of rolls. In these four stands the $4\frac{3}{8}$-in. billets are reduced to $2\frac{1}{2}$ in. billets about 71 ft long. They are delivered onto a roller table clearing number four stand of rolls before entering the up-and-down-cut shear where they are cropped and divided into two pieces each about 35 ft long and weighing about 700 pounds each. The normal time consumed by the breakdown mill, cropping, cutting and conveying the $2\frac{1}{2}$-in. billets into the holding or reheating furnace totals 50 to 60 seconds. During this time, the surface of the steel will show a temperature loss of 300 F or more; the center of the billet at the shear cut will show a loss of 190 to 220 F, with variation dependent on the skill of the shear operator. To attempt to roll a $\frac{7}{32}$-in. rod from both billets from the original heat would be impractical. Therefore another heating or holding furnace, which is unique in design, is located at the end of the shear table and in line with entry into the furnace. From the shears, the billets are charged directly into the holding furnace by a set of electrically driven pinch rolls.

The hearth in the reheating or holding furnace is flat; 8 ft-4 in. wide and 37 ft long. The furnace has a suspended flat roof. It is a single zone, top-fired design with the same controls as the heating furnace. The furnace holds twenty-four $2\frac{1}{2}$-in. billets when fully charged. At normal rates of operation, nine to ten minutes is available to bring the steel back to a desirable rolling temperature. At the higher rates of operation, a temperature differential between the actual surface temperature of the steel and the furnace indicated temperature exists in the amount of 40 to 50 F. In addition to reheating the billets, the holding furnace acts as a reservoir to level out possible intermittent operations on either the breakdown mill or the rod mill. Close control of temperature and time in the furnace permits our mill to produce a more uniform rod section, and also produces an improved surface on the finished rod due to the light scaling of the billet.

Following the holding furnace the rod mill proper is a conventional 23-stand continuous mill. Square-

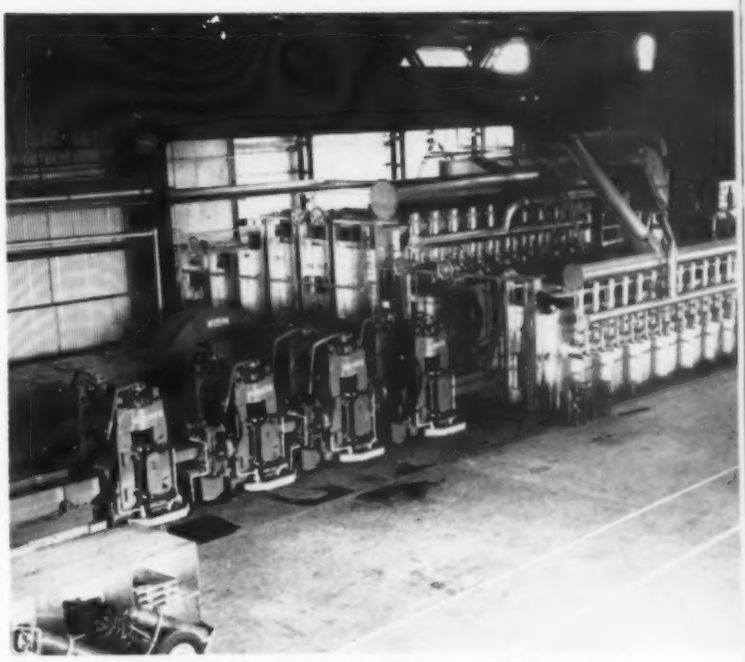


Figure 5 — The four-stand breakdown or billet mill reduces the $4\frac{3}{8}$ in. billet to $2\frac{1}{2}$ in. billets.

diamond pass design is used in the nine roughing stands, ovals-square in the next eight stands, and rounds-ovals in the last six stands of rolls in the finishing train. When this 23-stand design using a $2\frac{1}{2}$-in. billet is compared with the old hand mill, which finished the same size rod from a $3\frac{7}{8}$-in. billet with 18 stands of rolls, it shows the trend to moderate reductions necessary to produce rods of highest quality.

This 23-stand mill has a flying crop-end-shear between roll stands 8 and 9. After the bar is cropped it continues through troughs until the front end enters and is engaged in No. 9 stand when the flying shear

Figure 6 — View shows the roller line from the breakdown mill; up-and-down-cut shear; holding furnace; general view of the 23-stand rod mill, with the double conveyor converging into a single conveyor and star wheel in lower left hand corner where coils are automatically transferred to the hook conveyor.

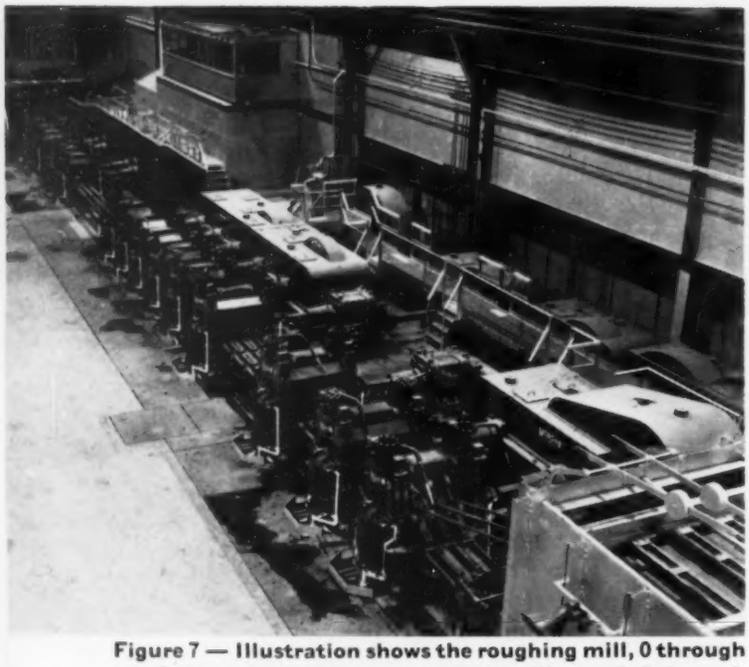


Figure 7 — Illustration shows the roughing mill, 0 through 8 stand; part of the intermediate mill, stands 9 through 13; and the control pulpit.

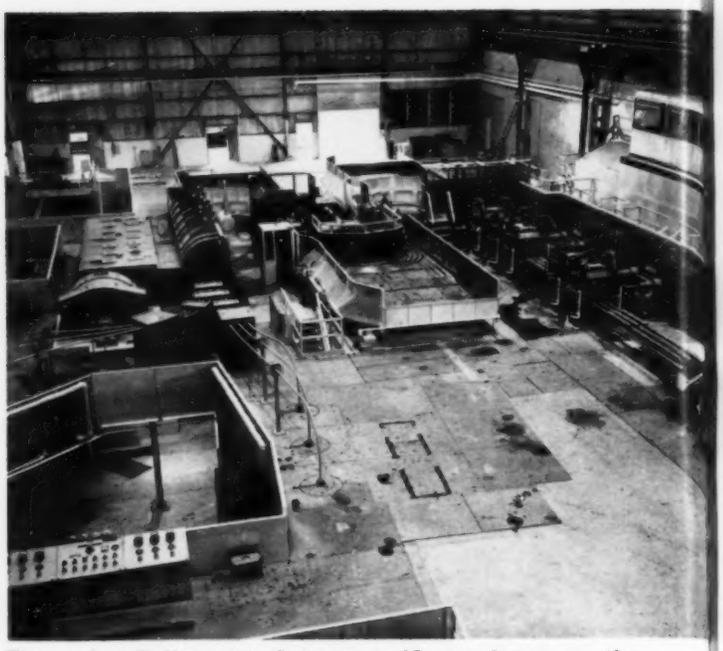


Figure 8 — Roll stands 9 through 13 are shown on the right; the three repeaters between 13 and 14, 14 and 15, and 15 and 16. Finishing train, reel pit and reel control desk are in the left foreground.

operator, by means of a lever, turns the trough over. This permits the bar to drop out of the trough making a sagging loop in the bar. As a part of the intermediate train of rolls, there are three 180-degree repeaters. These are located between roll stands No. 13 and No. 14; between stands No. 14 and No. 15; and between No. 15 and No. 16 which is the first stand in the finishing train. The first repeats an oval from 13 to 14, the second repeats a square from 14 to 15, and the last repeats an oval from 15 to 16. The three repeaters and the sagging loop provide the operator with a means to relieve stretch in the bar that otherwise might be difficult to control. In these four loops, as the section is smaller, the pushing or stretching of the bars between stands is better controlled by adjusting the rolls to allow for a growing free loop around the repeaters, thus relieving tension that otherwise could be present to a varying degree and effect the dimensions of the finished rods.

On the entry side of No. 15 roll stand there are three snap shears, one for each rod strand. These are operated by push button control either from the floor or from the motor control pulpit. As a cobble is made in the finishing train, the snap shear cuts the bar at roll stand No. 15 minimizing the amount of scrap rod to be pulled out of the finishing train.

Rod sections over $\frac{3}{8}$ in. in diameter and up to $1\frac{1}{8}$ in. in diameter (at present $\frac{3}{4}$-in. diameter is the largest we have made) finish through roll stand No. 15 and deliver to either of two pouring reels. At present these sizes are rolled single strand, however, provisions were incorporated in the construction for two additional reels for future double strand rolling. The two pouring reels deliver the coils to one of the two flat conveyors.

Control pulpits are located near the pouring and laying reels with a reel operator to operate the electric controls which actuate the stripping and pushing mechanisms, synchronized with the speed of the entire conveyor system. The two flat conveyors carry the coils a distance of about 200 ft at which point the double conveyor converges into a single conveyor forming a single line of coils in position for the star wheel to make the transfer automatically to the hook conveyor. This transfer is made approximately 12 minutes after the coil leaves the reel and has cooled enough to avoid distortion. The hook conveyor is 1400 ft long and, after leaving the mill, rises enough to clear a railroad track and an automobile roadway, then lowers to enter the unloading station. The effective cooling length is about 900 ft before the coils are removed from the hook conveyor by air hoists suspended from an overhead beam. Coils are then trans-

Figure 9 — View of one of the rod shuttle cars shows position of bundles on the car, the air lift, and the remote control for spotting the cars at the rod dock.

ferred onto special-built standard gage railroad shuttle cars which transport them to the wire mill rod dock. There are two sets of two cars, each with an electric locomotive. One man operates both locomotives riding the loaded trip to the rod dock, waiting for the unloading and returning the empty trip to the loading station. The trip being loaded from the hook conveyor is controlled by the air hoist operator who, by push buttons, controls the movement of the electric locomotive to spot the cars as desired. Shuttle cars are designed to fit rod dock and cleaning house equipment. Each car has ten racks holding five bundles in an upright position. Each rack load equals a pin load for wire mill lift trucks and becomes the standard pin load for all cleaning house and drawing room movements. As each set of shuttle cars has a capacity of 100 bundles, the round trip is usually made in about 30 minutes.

With this brief description of the mechanics of the mill let us follow the points of interest in rolling through the mill. On a bell signal from the mill feeder, the billets are pushed from the holding furnace by a water-cooled peel bar which is driven by pinch rollers. As the billet emerges from the furnace, it enters an hydraulically operated billet switch which guides the hot billet into any one of three passes that the mill feeder selects. At the delivery side of roughing stand No. 8, the front end of every bar is cropped by a flying shear operated automatically or manually. After the flying shear, the bars pass through the intermediate mill and three sets of repeaters to enter the seven-stand finishing train. When rolling $\frac{7}{32}$-in. rod out of stand No. 22 at 5000 fpm, 3-strand rates as high as 56 tons per hour are obtained. The three strands are piped to six laying reels. Each strand has an electric eye located at entry to No. 16 stand which activates an air cylinder for switching from one reel to the next. Installed in the reel pipes are a series of descaling, cooling and water eliminating jets cased in boxes. The off-and-on flow of this water is accomplished by solenoid valves actuated by the same electric eyes as those mentioned above. The descaling and cooling of the rod is most important. Normally the hot rod temperature entering the reel is about 1700 F. With 700-lb coils it is necessary that very close control be maintained on the finished coil temperatures to minimize the formation of cooling scale and thus to obtain desirable rod surface qualities and economic acid and time consumption in the cleaning house. Our best results are obtained with finished coil temperatures of about 1450 F.

The ten mill motor drives are of shunt design for 600-volt d-c and operate under adjustable voltage control. Power for these motors represents a total of 7150 hp which is supplied by three 1500-kw, 600-volt generators driven by a 6300-hp, 6600-volt synchronous motor. All the mill motor drives are controlled by the speed control operator in the control pulpit. These are desk type controls that have facilities for coarse or fine adjustment of generator voltage, or can make separate adjustment of speed of each motor by field control. A master motor-operated rheostat acts to change the voltage for the entire mill over a range of from zero to 600 volts, while other rheostats may be

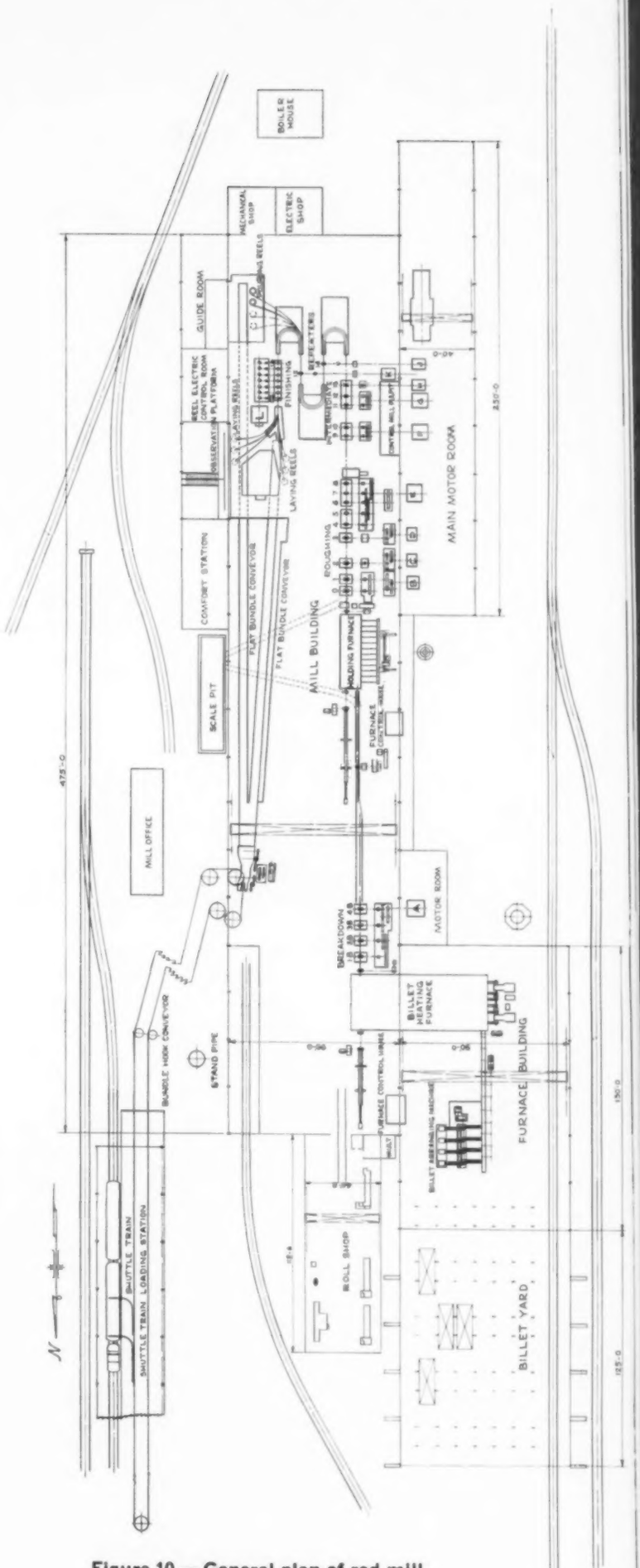


Figure 10 — General plan of rod mill.

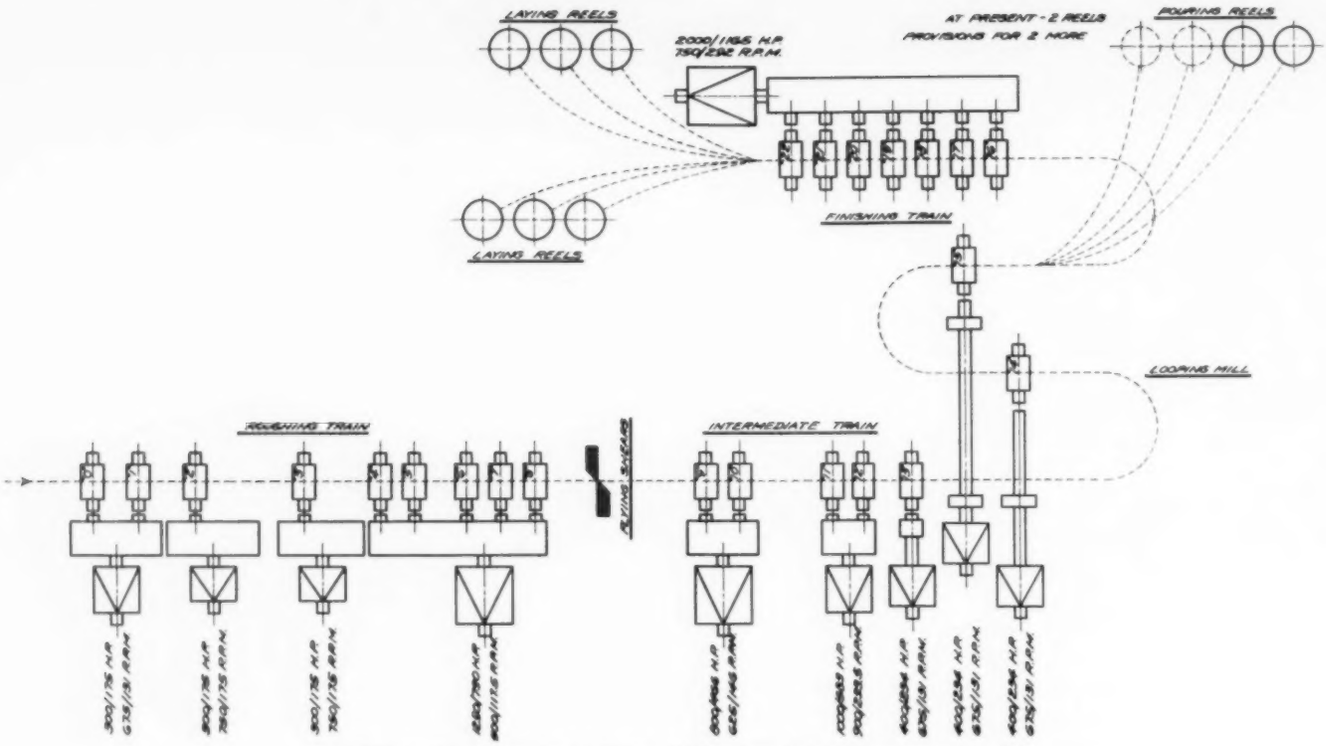


Figure 11 — General layout of 23-stand continuous rod mill.

varied to adjust the voltage on each individual bus section. Thus, all mill motors are started by generator field control and speed changes can be made for the entire mill as a unit. Each motor has an overspeed device that will disconnect the motor from the line in case of speeds exceeding pre-set limits. All of the generator sets and mill motors have temperature relays installed on the bearings to guard against overheating or failure in the lubricating system. The motor room is pressurized and temperature controlled by circulating water-washed air.

Roll housings in the four stands of the breakdown or billet mill, the nine stands of the roughing mill, and five stands of the intermediate mill are of open top design. Roll stands No. 14 through finishing stand No. 22 are of the closed top design. A complete set of spare housings for stands 9 through 22 are provided. These spare housings are built up on the floor prior to anticipated roll or section changes. The use of a fork-lift truck to move, position and hold the rolls in the build-up has proven very successful. Steady, precise positioning is possible to a larger extent than that obtainable with the overhead crane. Further, the crane is relieved for emergency mill service. All stands are equipped with fabric bearings. Open type bearings are used with all the open type housings and enclosed type bearings with all the closed housings. The enclosed bearings are assembled and attached to the rolls in the roll shop.

Guides are an important item in any rolling mill and especially so in a high-speed mill guiding small sections. On alternate roll stands there are guides that twist the bars through a 90-degree angle to set the bar up accurately for entry into subsequent passes. Accurately ground guides are required to reduce scratches on the bars and permit the mill to produce a higher quality of surface and section. The correct degree of twist in the twister guides is accomplished by the special fixtures used on the guide grinding machine. This machine is hydraulically operated and is capable of grinding all of the types and sizes in this mill.

The rod mill roll shop is 112 ft long and 40 ft wide, and adjoins the north end of the main building. It houses two 18-in. tandem lathes, one contour lathe, one roll grinder, one 14-in. twin emery wheel stand for grinding carbide tools, one 12-in. emery wheel stand for grinding high speed tools, and one surface grinder used for grinding gang tools. Most of the floor space is filled with up-right roll racks capable of holding six complete sets of rolls for each of the 27 stands in the mill. A small area at one end of the shop is assigned to the bearing assembly for the finishing and looping mills. Here closed type roll neck bearings are removed from worn rolls, cleaned, repaired, and replaced on new or redressed rolls.

The contour lathe is used to rough off the bodies of all new rolls to desired diameter. It is also used to turn up all new rolls and does the roll dressing for the 4-stand breakdown mill and the 9-stand roughing mill. Carbide tools are used exclusively. The two 18-in. tandem lathes are set up so one lathe handles the intermediate and looping mill rolls, stands 9 through 15. The other handles the finishing mill rolls, stands 16 through 22. Carbide blade tools are used to face off the bodies of the rolls while high-speed steel gang tools are used to put in the passes. The roll grinder is used to regrind built-up necks. All the rolls and lifts are handled by a 5-ton single trolley, single hoist overhead traveling crane operated by push button control from the floor.

All of the gear drives and pinion stands are lubricated from four central circulating systems. Each system is served with centrifugal oil purifiers to maintain a clean and moisture-free oil.

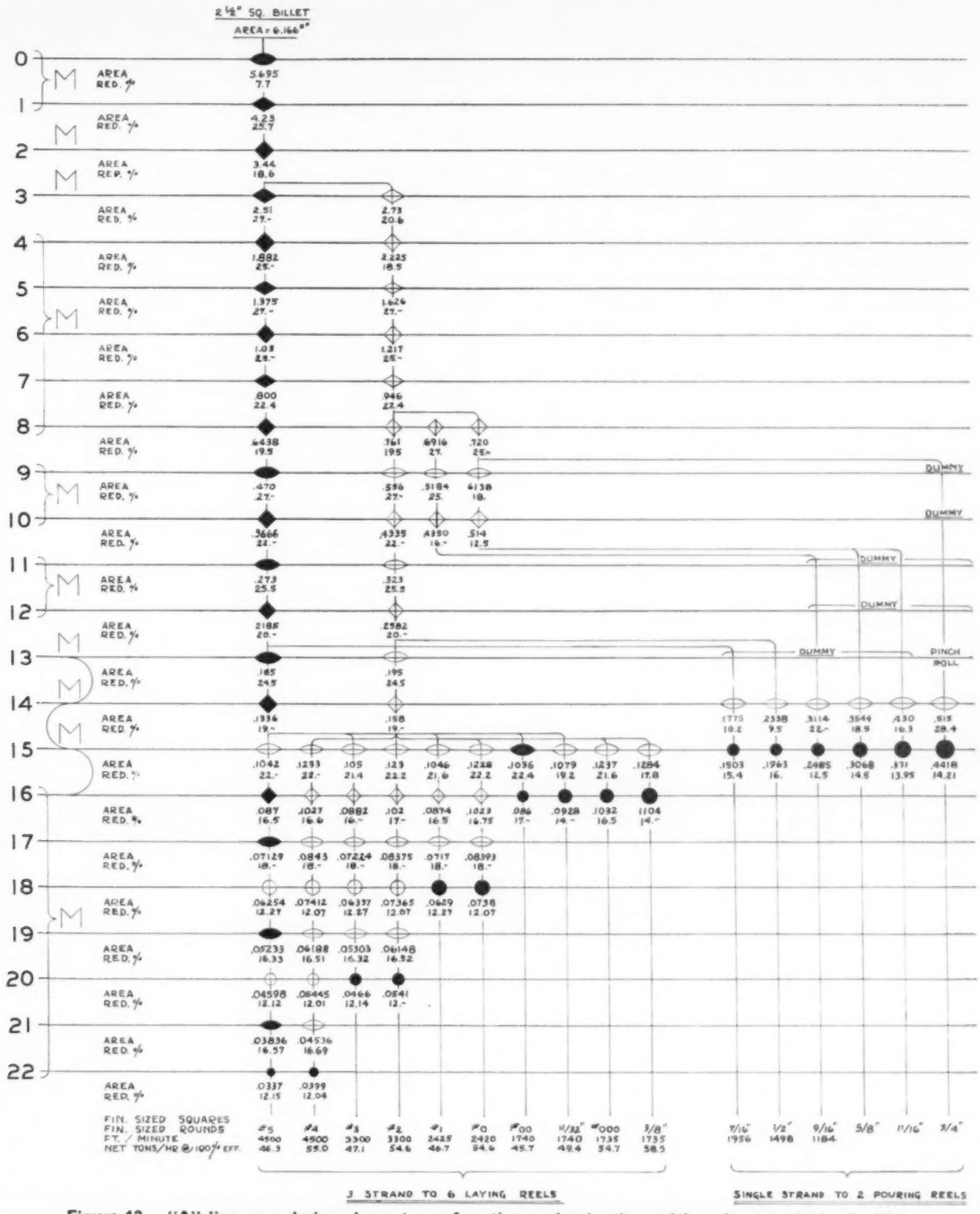


Figure 12 — "A" line pass design shows type of section and reductions with various methods of rolling.

System No.	Capacity, gal	Circulation, gpm
1	5,000	120
2	13,000	295
3	4,500	90
4	900	20
Totals 4	23,400	525

System No. 1. Lubricates the gears and bearings of the four stands of the breakdown mill; the drives for the charging and pushout equipment on both the heating and holding furnaces; the drive for the up-and-down-cut shear; and the drives for the rod conveyors.

System No. 2. Lubricates all the gears, pinions and bearings for roll stands No. 0 to No. 15 inclusive.

STARTING BILLET - 2½" x 2½"
WEIGHT - 650 TO 740 LBS. ROLLING PROCESS UNIT: INCHES

STD.	ROLL DIA.	ROLL MAKE	R.P.M.	SECTION	SEC. SIZE	% REDUCT.	NO. OF PASSES	NO. OF STRAND
"0"	16"	CHILL TYPE	7.0825	⬬	3.139" x 2.562"	8.8	9	3
"1"	16.5625"	"	8.76	◆	3.148" x 2.206"	24.8	"	"
"2"	"	GRAIN TYPE	10.94	◆	1.869"	18.6	"	"
"3"	"	"	14.47	◆	2.817" x 1.533"	27.0	"	"
"4"	14.5625"	"	22.811	◆	1.384"	26.06	15	"
"5"	"	"	29.872	◆	2.044" x 1.133"	26.13	"	"
"6"	"	"	40.127	◆	1.033"	24.41	"	"
"7"	"	"	50.43	◆	1.522" x .861"	22.5	"	"
"8"	"	"	63.96	◆	.821"	19.88	"	"
"9"	13.50"	"	92.723	●	1.105" x .611"	27.2	18	"
"10"	"	"	120.32	◆	.616"	21.8	"	"
"11"	"	"	158.475	●	.792" x .451"	25.6	"	"
"12"	"	"	200.48	◆	.475"	19.9	"	"
"13"	"	"	263.0	●	.661" x .35"	24.5	"	"
"14"	13.00"	"	338.89	•	.375"	19.0	30	"
"15"	"	"	431.00	•	.554" x .26"	22.0	"	"
"16"	10.25"	CHILL TYPE	657.16	•	.308"	16.5	"	"
"17"	10.26563"	"	787.064	•	.525" x .21"	18.83	"	"
"18"	10.375"	"	910.416	•	.290"	12.27	"	"
"19"	10.4606"	"	1030.384	•	.437" x .170"	16.8	"	"
"20"	10.7968"	"	1183.67	•	.250"	11.45	"	"
"21"	11.046875"	"	1348.661	•	.359" x .150"	16.35	"	"
"22"	11.15625"	"	1555.869	•	.221"	12.24	"	"

MILL PRODUCTION RECORDS

8 HRS.	425	TONS	10-10-51
16 HRS.	773	"	9-28-51
24 HRS.	1122	"	9-28-51
MONTH	25339	"	1-1952
YEAR	264595	"	1951

Figure 13 — Additional data on rolling 2½ x 2½-in. billet on "A" line is given in this table.

System No. 3. Lubricates the gears, pinions and bearings for the finishing train, stands 16 to 22 inclusive.

System No. 4. Lubricates the gears and bearings of the six laying reels and the two pouring reels.

Each system is equipped with two pumps either of which will circulate the required amount of oil with a maximum discharge pressure of 60 psi. Both pumps operate until operating pressures are reached then one pump shuts off and will not run until there is a drop in line pressure of 10 psi. Each system is equipped with steam coils and oil coolers which maintain oil temperature at 100 F; also each system is equipped with signal lights and a howler to indicate operations.

The excavation for this mill began on June 9, 1948. Construction required 68,800 cu yd of excavation and grading; 12,014 cu yd of concrete; 340 tons of reinforcing steel; 1418 tons of structural steel; 9½ miles of conduit; 16 miles of ⅜ to 4-in. diameter pipe (not including water mains); and 27 miles of electrical wiring. The mill was completed in 445 days and began operations August 29, 1949. Two weeks later September 12 and 13, the West's greatest open-house celebration was staged by the Colorado Fuel and Iron Corporation. On opening day, 5500 out-of-town visitors, and on the following day 4500 local people visited America's most modern 3-strand high-speed rod mill.

The introduction of this modern mill presented many problems, and most important, the training of people. By local agreement all of the Garrett rod mill employees' positions and relative seniority on the old mill was recognized in the crew organized for the new

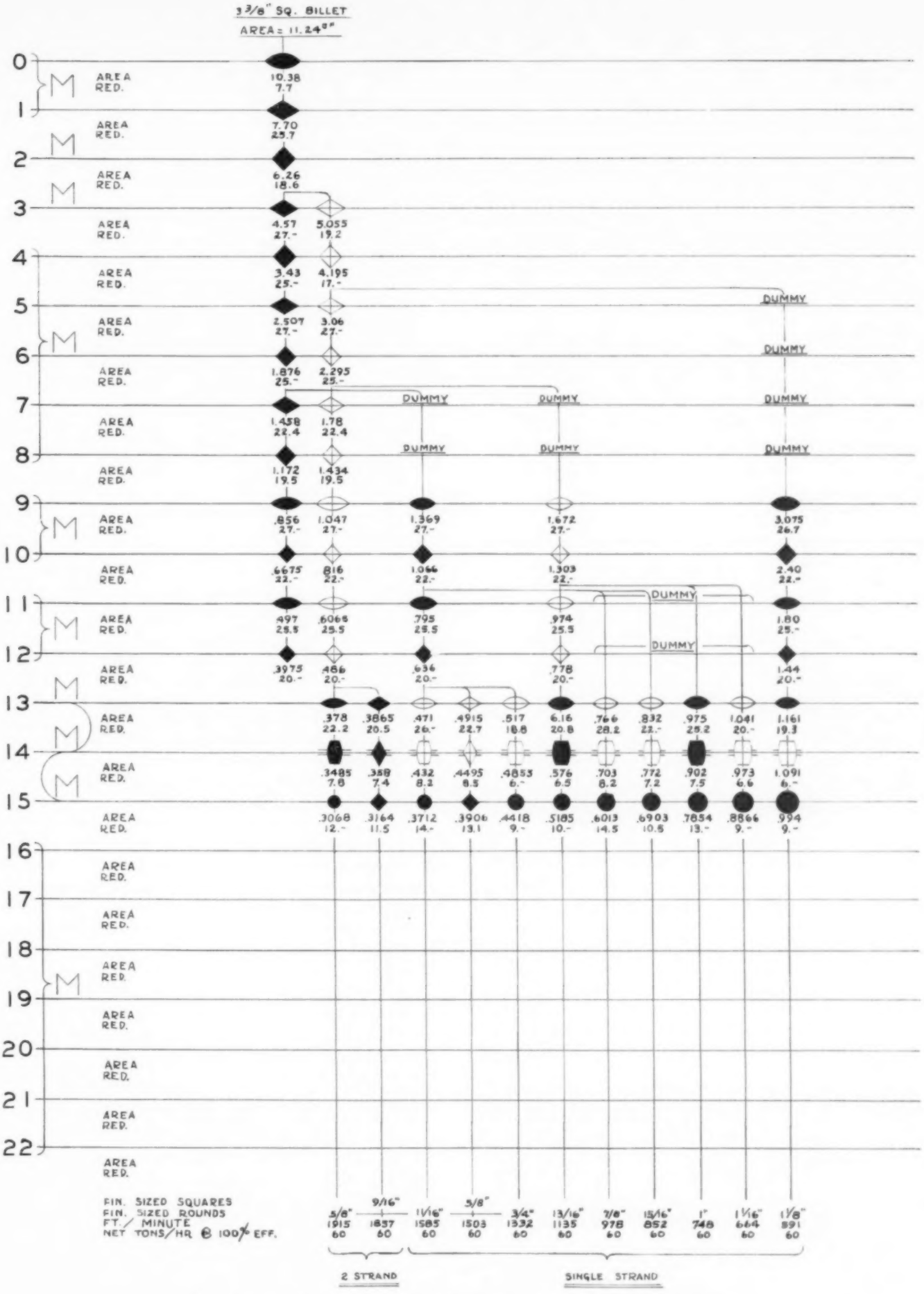


Figure 14 — "B" line pass design shows type of section and reductions.

operation. Each employee had six months to decide whether to accept a new job in the new mill or to stay with the position in his particular seniority group which was left at the 10-in. mill.

Of the original Garrett mill crew, only a few had a vague idea of continuous rod mill operation. With these few as a nucleus and with experience and increasing know-how, operations have been developed to where four trained crews are now available. As a matter of record, the first million tons of rods were produced at 7:40 pm on May 18, 1954, 4 years and 9 months after starting. One of our statisticians likes to relate that could all of this million tons have been in $\frac{7}{32}$ in. rod, it would have been enough to go around the world 118 times or to perhaps build around the equator a fence 59 ft high with strands spaced at 6-in. intervals.

Other records since the millionth ton rolled are as follows:

July 2, 1954	8 hours	449 tons	56.12 tons/hr
July 2, 1954	16 hours	844 tons	52.75 tons/hr
Apr. 18, 1955	24 hours	1196 tons	49.83 tons/hr
May 9, 1954	Week 144 hours	6642 tons	46.14 tons/hr

DISCUSSION

PRESENTED BY

FRANCIS G. KREDEL, Superintendent Bar Mills, Republic Steel Corp., Cleveland, Ohio.

V. W. JOHNSON, Superintendent of Rolling Mills and Finishing, The Colorado Fuel and Iron Corp., Pueblo, Colo.

SHERIDAN A. SMITH, Superintendent of Rolling, The Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada.

D. G. MAGEE, Industrial Sales Engineer, General Electric Co., Denver, Colo.

Francis G. Kredel: You spoke about closer tolerance on a rod. I would like to know what tolerance you aim for and what tolerance you get on a No. 5 rod as compared with a $\frac{3}{8}$-in. rod?

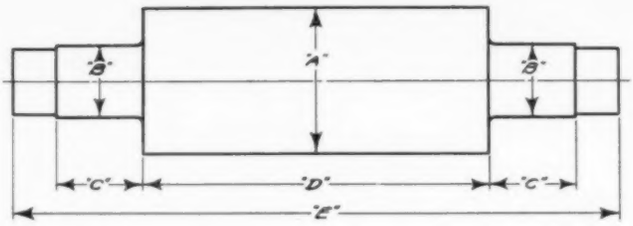
V. W. Johnson: Out at our plant we have the nominal tolerance of ± 0.015 in. on all rods. We can aim for 0.218 in. on $\frac{7}{32}$ rod. That gives us a range of from 0.203 to 0.233. We aim to stay around 0.225 or slightly under. However, our inspection is such that anything that is out of this tolerance is scrap against the production of the mill.

Sheridan A. Smith: I would like to ask Mr. Johnson the temperatures of his No. 5 rod as it is coming off his laying reel; and how much high-pressure water does he use in his pipe.

V. W. Johnson: Normally our rod enters the reel at about 1700 F. Now it is controlled by an electric eye with solenoid valves on our spray and water eliminator with pump pressures at about 70 psi, and we get readings of 1,450 F or under.

Sheridan A. Smith: Have you found out how low you can go on that cooling?

ROLL DIMENSIONS



STD.	"A" DIA.	"B" DIA.	"C"	"D"	"E"
"0"	16"	10"	13.25"	40"	6'-9.25"
"1-2-3"	16.5625"	"	"	"	"
"4 TOP"	14.5625"	8.5"	12.125"	36"	6'-1.5"
"9 TOP"	13.5"	"	"	28"	5'-5.5"
"14 TOP"	13"	7.25"	9.5625"	24"	5'-2.5"
"16"	10.25"	6.25"	8.8125"	20.5"	55.375"
"17"	10.2656"	"	"	"	"
"18"	10.375"	"	"	"	"
"19"	10.4606"	"	"	"	"
"20"	10.7968"	"	"	"	"
"21"	11.0468"	"	"	"	"
"22"	11.1562"	"	"	"	"

Figure 15 — Roll dimensions are given for the various rolls when rolling No. 5 rod.

V. W. Johnson: No, I do not know how far we can go. On coarser rods, on our $\frac{3}{8}$-in., we can not go that low, because being a laying reel, the long end will not flow out as readily as the $\frac{7}{32}$ in. does. However, our wire people say anything from 1,450 F or under is sufficient to take care of their needs, if that is what you have in mind.

Sheridan A. Smith: I had this in mind. I have laying reels but I found out as soon as I get down below 1500 F I had trouble due to cobbles.

V. W. Johnson: We are able to get 1,450 F or under.

Sheridan A. Smith: How far do you mean under?

V. W. Johnson: I do not know. Our pyrometer only goes to 1450 F. How much under that it may be I cannot answer.

Member: Mr. Johnson, in your opinion, from the standpoint of maintaining accuracy within the limits of rod tolerances, would you consider it practical to have a straight line rod mill delivering straight into the finishing stands?

V. W. Johnson: All I can give is a personal opinion. I personally like to see some place along the line where you would have an opportunity to have either a drag in your rod or repeater where you could have some slack, because I think you do need something like that for accuracy.

However, I might say that we have tested bundles the full length of coil, at 40-ft intervals, and we do not find too much variation. Of course, we measure it two ways: the up and down measurement, which, of course, would tell you what your bearings or spring of the rolls amount to, and the side measurements, which would indicate any pull you might have in your mill, and it is surprising how close they come out. We measured one just recently and four-thousandths variation was what we got on the rod both ways.

Sheridan A. Smith: I think Mr. Johnson has a wonderful setup for cold heading. You stated you use a $4\frac{3}{8}$-in. billet. Have you a conditioning area some place.

V. W. Johnson: Except on certain grades of steel, we cold scarf or spot scarf, I should say, with scarfing torches. We have no hot scarfing facilities.

Sheridan A. Smith: I would judge you get some pretty good results from your setup, then, as it is ideal for rolling cold heading.

V. W. Johnson: We have not been in the cold heading business too much, but on occasional heats we will spot scarf.

D. G. Magee: Mr. Johnson is to be commended for his fine paper. One point I would like to expand upon is the records this mill holds. All of the tonnage figures listed at the end of his paper are world records. The eight-hour record of over 56 tons per hr of $\frac{7}{32}$-in. rod, for example, is nearly 20 per cent above the designed tonnage of 45 tons per hr. These records are not easily made. Obviously you must have the best equipment designed to operate as a coordinated system. Just as the mechanical components must be specifically designed and arranged for this particular mill, so too must the electric drive systems and control be especially built to have the proper characteristics to synchronize the speeds of the mill stands so they will perform as a unit under a wide range of rolling conditions. However fine equipment alone will not insure records. These records are the result of excellent training, a sound understanding of the mill, the best of maintenance and good equipment.

When this mill was placed in operation, many of the Garrett mill employees were distrustful of the new mill and were not sure they would stay. Today, if you ask these operators how they feel about the three-stand mill, they will say it is the best in the world. You can tell all concerned are proud of their mill by the outward appearance of the mill. The motor room sparkles and the whole mill area is kept clean and neat.

Mr. Johnson has devoted many hours to analyzing his mill so that the reductions are taken at the proper place, and he has put a great deal of time into instilling this "know how" into his crews. He is continuing to study his mill every day, and it will be no surprise to me if this mill continues to break records periodically.

MINES BUREAU SMELTS ORE WITH ANTHRACITE-COKE BLENDS

▲ POINTING to a possible new market for the hard-pressed anthracite industry, the Bureau of Mines reported recently that a blend of 40 per cent anthracite and 60 per cent coke from bituminous coal has been used successfully for making pig iron in an experimental blast furnace at Pittsburgh, Pa.

This represents the highest percentage of "hard coal" used in such an operation in modern times since the anthracite portion seldom has exceeded 10 per cent of the fuel charged to a commercial blast furnace, and then chiefly during coke shortages.

The recent tests at Pittsburgh were made with iron ore from Minnesota's Mesabi range.

While economic factors were not considered during the runs, it appears that further experimentation might develop a combination of furnace design and raw materials that would make smelting of iron ore with anthracite commercially attractive.

The generally favorable results of these tests should encourage experimentation with the increased use of anthracite in locations where this fuel is competitive in cost with coke.

A detailed report on the test runs also noted:

"If, in a period of hostilities, a sudden increase in demand for steel should develop or coke ovens were destroyed, the country might have to depend to a very large extent on the use of anthracite in blast furnaces."

The Bureau tests were part of a broad research program designed to develop new uses for anthracite.

Anthracite was one of the first fuels that replaced charcoal in American blast furnaces. In 1874 nearly half the country's pig iron was produced in anthracite-fired furnaces. After 1880, however, construction in the Pittsburgh area of larger blast furnaces operating wholly on coke led to a rapid decline in this use of anthracite.

During the tests in the experimental blast furnace, good quality pig iron unusually low in sulphur was made without difficulty with anthracite-coke ratios up to 40-60, and there was little difference in operation with any proportion of anthracite to this point.

The experimental blast furnace, although having most of the characteristics of a modern commercial furnace, is not a scale model, and not enough time was available for these preliminary tests to permit study of all the variables. For this reason, the maximum anthracite-coke ratio that would give satisfactory performance in a commercial operation would have to be determined by tests run in a full-sized furnace.

Single copies of R. I. 5165, "Smelting Iron Ore With Anthracite; Bureau of Mines Experimental Blast Furnace," can be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa. It should be identified by number and title.

AISE Pictorial Review

1955 Annual Convention

September 26, 27, 28, 29

HOTEL SHERMAN CHICAGO, ILL.

1

A total of 2386 registered at the 1955 annual convention of the Association of Iron and Steel Engineers held at Chicago's Hotel Sherman, September 26, 27, 28, 29.

At the business meeting held Monday morning, President John H. Vohr (1) officially opened the four-day convention.

2

Authors of the various technical papers met each morning with the chairmen at breakfast to work out details of their particular sessions. Shown in (2) are participants in the Operating Practice Session: C. R. Austin, E. C. Wright, G. I. Bottcher, and James MacGregor. The Blast Furnace Session (3) included: Victor Paschkis, C. G. Hogberg, W. A. Smith, E. O. Austermiller, J. A. Bell and E. N. Hower. Taking part in the Lubrication Session (4) were: J. B. Moore, D. N. Evans, W. B. Bauzenberger, B. W. Siemon, M. S. Clark, and E. T. W. Bailey. An Electrical Session group is shown in (5). Seated are: R. G. Nolan, D. C. McCrady, E. A. Young, and C. S. Hague, Standing are: A. C. Stoever, A. D. Millikin and Frank Nolan. Shown in (6) are authors and chairman of the second Lubrication Session: C. T. Lewis, T. M. Murphy, D. E. Whitehead, and W. E. Rigot.

3

One of the highlights of the AISE ladies program was an afternoon tea on Monday, September 26 at Marshall Field's Wedgewood Room. (7)

Bill Zelley, John A. Roebling's Sons Co., and M. D. Egan, Clark Controller Co., (8) take time out between sessions to talk shop.

In (9) are Jim Bottoms, Mesta Machine Co., and O. K. Moynihan, Wheeling Steel Corp.

4

Shown in (10) are: Lou Moses, Bethlehem Steel Co., C. H. Johnson, United Engineering and Foundry Co., W. C. Higdon, Sheffield Steel Corp., P. A. Ellis, United Engineering and Foundry Co., and R. C. Schaefer, Wheeling Steel Corp.

P. H. Reynolds, Jones and Laughlin Steel Corp., (11) talks things over with F. M. Eder, General Electric Co. and G. C. Miller, Kaiser Aluminum and Chemical Corp.

5

Pictured at the reception for the speaker's table guests are: President Vohr, H. W. Johnson, Inland Steel Co., and A. J. Cochran, manager Chicago District, Youngstown Sheet and Tube Co.

A total of 770 people attended the formal dinner (14) on Wednesday, September 28.

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By L. I. DICKINSON, Assistant Fuel Engineer, Bethlehem Steel Co., Lackawanna, N. Y.

Heat Balance Studies in an integrated steel plant

. . . . careful studies on the heat balance in the steel plant can indicate worthwhile economies and savings . . . . with careful control, this plant was able to reduce the amount of purchased fuel from 0.184 net tons of bituminous coal equivalent per net ton of ingots to 0.106 net tons per ton of ingots . . . .

▲ A heat balance study in an integrated steel plant is a big subject, primarily because of the magnitude of such a plant and because of the great number of heat applications involved. Few other industrial establishments use as much energy in the form of heat as an integrated steel plant.

An integrated steel plant, being concerned with all the various processes, from raw material to finished product, should be so designed that the productive capacities of the various departments are in proper relation. At the same time there should be sufficient service facilities so that full use may be made of all available energy released as by-product fuels in plant operations.

A "Heat Balance" may be defined as a list of items of heat input equated against a list of items of heat given off or carried away from a particular unit. In an integrated steel plant, where all raw materials are received and all finished products are shipped at approximately the same temperature, a measure of the heat balance lies in the amount of fuel necessary to carry on the operation, since all of the heat supplied as fuel is dissipated before shipment of the final product. The smallest heat input required to carry on plant operations determines the most economical balance, and the greater percentage of the heat requirements that can be supplied as by-product fuels will result in a decrease of more expensive or purchased fuels.

While a series of individual heat balances can be drawn for each individual process, this paper will be limited to a heat balance for the entire plant, as measured by the fuel input. This cannot be presented in a simple manner because of the wide variety of systems, including three gas systems and three steam systems, at the Lackawanna plant.

The Lackawanna plant recently completed an expansion program aimed not only at increased capacity but also at a more complete integration of the plant. This program included a new battery of coke ovens, a new blast furnace with blowing equipment, four open hearth furnaces, complete with waste-heat boilers, and additional blooming mill pit capacity. In addition to this, to fulfill fuel requirements which will be outlined below, equipment was added so that four of the coke oven batteries, including the new one, could be underfired with either blast furnace or coke oven gas. Additional service equipment, including a steam generator, an extraction turbine and a water pumping station, were built.

When this expansion program was contemplated, the entire fuel and power balance of the Lackawanna plant was studied to see what should be incorporated in the program to insure full use of the energy released as by-product fuel. This included a study of the consuming units, as to the equipment installed, taking into consideration the various fuel interchanges which had been utilized in the past. The equipment of the plant is shown in Table I. The mills marked with an asterisk had the necessary equipment for burning either a gaseous or a liquid fuel.

The by-product fuels available at Lackawanna are coke oven gas, blast furnace gas, tar or pitch, and coke breeze. In addition, the waste gases from the high-temperature melting furnaces in the open hearth may be used for the generation of steam. It will be noted here that all of this by-product fuel comes essentially from the coal used for coke production because one ton of coal will yield 10,000 to 10,500 cu ft of coke oven gas at about 540 Btu, 8 to 8.3 gal of tar or 6.7 to 7.0 gal of pitch, and 0.02 to 0.05 tons of coke breeze. The re-

TABLE I

Tabulation of Main Fuel Consuming Units

		Capacity	Fuel used	Normal demand				
				CO	BF	Nat.	Oil	Coke breeze
Coke ovens	7 Batteries	217,000 NT/Mo	CO or BF gas	1-2-3 813,000	4-5-6-7 6,500,000			
Blast furnaces	7 Furnaces	260,000 NT/Mo	BF gas	Stoves Engines	7,430,000 2,447,000			
Open hearths	34 Furnaces	420,000 NT/Mo 5,000,000 NT/Yr	Pitch-oil Gas	2,447,000				
Mills—44-In.	32 Pits (4280 sq ft)		Mixed BF and CO gas	200,000	1,200,000			
32-In.	2 Furnaces (1350 sq ft)		Mixed BF and CO gas	80,000				
40-In.	23 Pits (3158 sq ft)		Mixed BF and CO gas	200,000	1,000,000			
54-In.	32 Pits (4280 sq ft)		Mixed BF and CO gas	200,000	1,300,000			
8-In.	1 Furnace (790 sq ft)	18 NT/Hr	CO gas	70,000				
10-In.*	1 Furnace (1815 sq ft)	40 to 50 NT/Hr	CO gas and natural mixed-oil	150,000		20	500	
12-In.*	2 Furnaces (1700 sq ft)	40 to 50 NT/Hr	CO gas and natural mixed-oil	150,000		20	500	
14-In.*	2 Furnaces (1986 sq ft)	60 NT/Hr	BF and CO gas mixed-oil	150,000	100,000		250	
28-In.	4 Furnaces (2888 sq ft)	100 NT/Hr	BF and CO gas mixed	250,000	400,000			
Strip mill slab*	4 Furnaces (5760 sq ft)	300 NT/Hr	CO gas and natural mixed-oil	840,000		80	3300	
Splice bar	1 Furnace (405 sq ft)	7.75	CO gas	20,000				
Annealing	55 Furnaces		Natural gas or CO gas	250,000		125		
Boiler house	47 Boilers		Blast furnace gas oil		18,000,000			14 NT/Hr
Sinter plant			CO gas	20,000				3.5 NT/Hr

sultant coke delivered to the blast furnace yields 130,000 to 140,000 cu ft of blast furnace gas per ton of coke or 95,000 to 100,000 cu ft per ton of coal charged at the coke ovens. In addition to these fuels the waste gases from the high-temperature open hearth furnaces are in sufficient quantity and hot enough to be used for steam generation.

Application of these fuels to the consuming units in the best possible manner to reduce purchased fuels is the next problem. All of the fuel consuming units were studied to determine past fuel requirements. These studies included hour-by-hour requirements as well as averages, because the maximum and minimum requirements were important to determine the variations that would have to be accommodated by the system. With the plant expanded and fuel supply and demand determined, the fuel supply could be allocated to the consuming units based on its best use. For a good many years the blooming mills had used, to good advantage, a proportioned mixture of blast furnace and coke oven gas. The heat requirements of a pit are generally low since the steel is charged into the pit hot, and, with all four sides of the steel exposed, a lower flame temperature fuel, such as a mixture of blast furnace and coke oven gas, can be used to good advantage. This lower flame temperature fuel should reduce the chances of ingot "burning." At the same time the higher flame temperature fuels, such as pitch and coke oven gas, should be saved for higher temperature work.

In the open hearth, ten years ago, oil was the major fuel but pitch was used as the exclusive fuel on four or five furnaces. Pitch, as a fuel, has a greater advantage in certain parts of the heat, namely during that part where a heavy slag covering is preventing the heat transmission to the metal below. At this period a heavy, more radiant, flame can better agitate and penetrate this slag and allow heat to be absorbed by the molten metal, thus speeding up the refining process. Conversely, with a furnace full of scrap, a highly luminous flame is not as necessary. To make the best use of fuels, then, dual liquid-fuel systems were applied to half of the open hearth furnaces to use a maximum of oil at the beginning of the heat with enough pitch to keep the lines open. Later in the heat, when the highly radiant pitch flame advantage could be utilized, the oil was decreased and pitch increased. The use of coke oven gas had, up to this time, been limited to the melt-down period of the heat, due to its low pressure and its sulphur content. If this gas was delivered at high pressure and desulphurized, it could replace oil. When a combination of gas and pitch was tried on the open hearth furnaces, a saving in heat time of approximately one hour was realized over an oil-fired furnace. With the advantages of a more radiant pitch flame and a more cutting gas flame, it was evident that the supply of pitch should be saved for the open hearth, together with enough coke oven gas to make up the requirements of the operating furnaces. It had also been established that the maximum gas that could be used would amount to 70 per cent of total fuel, with remaining 30 per cent as pitch.

As to other fuel uses, the blast furnace stoves and gas engines were designed to use blast furnace gas and their requirements were established. However, at the coke ovens the batteries had been supplied with coke oven gas for underfiring. In the past our fuel structure was out of balance because our supply of blast furnace gas was exceeding the demand. Therefore additional coke

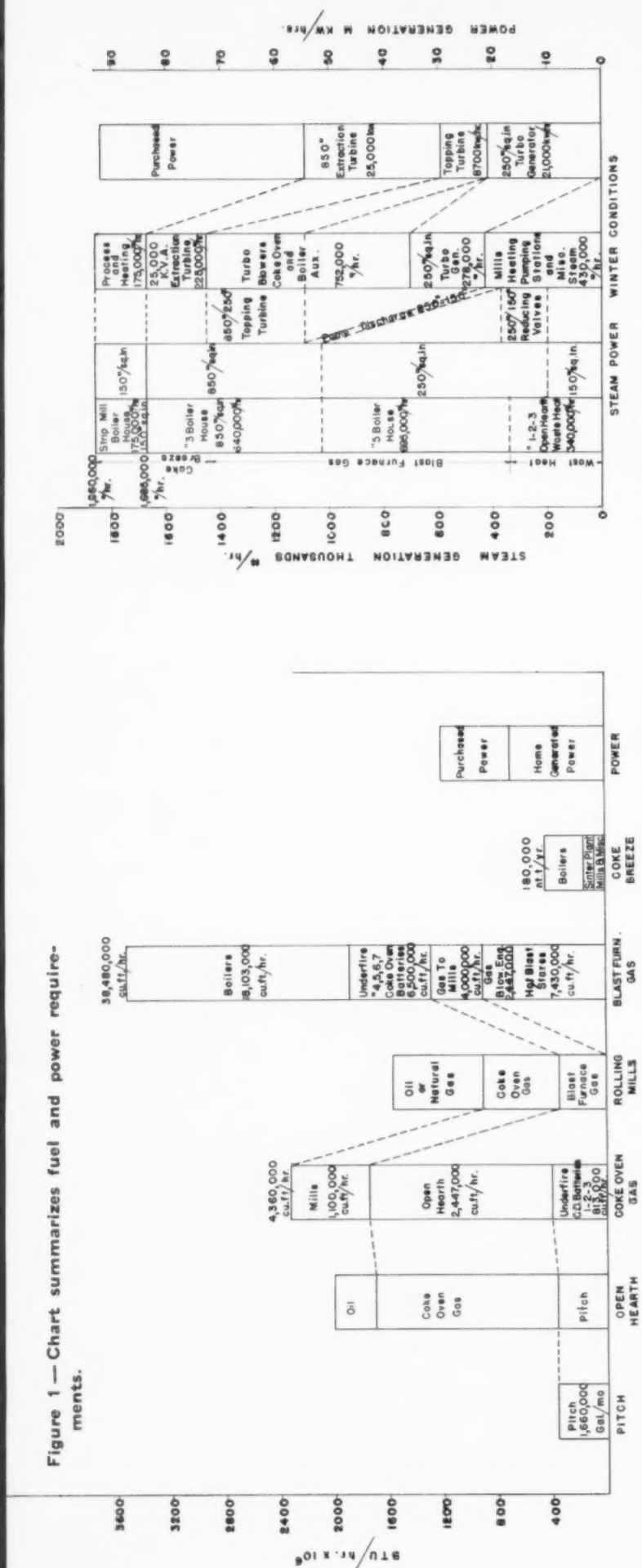


Figure 1 — Chart summarizes fuel and power requirements.

gas could be obtained if we could underfire some or all of these batteries with blast furnace gas. Four of these coke oven batteries, including the new one to be built, lent themselves to conversion to blast furnace gas underfiring, and the necessary equipment was added. The balance of the coke oven gas not burned in the open hearths could be used in the mills as had been done in the past, and any shortage would have to be made up as purchased fuel in the form of oil, or natural gas. The net aim of this whole plan was, of course, to use all of the by-product fuels wherever possible, and to use the smallest amount of purchased fuels.

However, with the fuel exchanges mentioned above there was still an excess of blast furnace gas, so an additional steam generator and a new turbine generator were added to the program. Here again the requirements of the consumer of steam had to be equated against the capacity of the units to generate steam, with particular reference to the different pressures of steam available. In the Lackawanna plant, three different main steam pressure systems are used: 850, 250, and 150 psi. Any increase in demand on the 150-psi system would be supplied by the 250-psi system by way of reducing valves, and the 250-psi steam was augmented by the exhaust of an 850/250-psi topping turbine to the limit of its load. Any excess 850-psi steam over and above the capacity of the topping turbine was pressure-reduced by reducing valves. Since we were making steam over and above the capacity of the topping turbine, an extraction turbine was added to the 850-psi system and the new steam generator was added to the 250-psi system. Addition of this steam generator fulfilled our requirements for that system and allowed more of the 850-psi steam to be used for power generation. The extraction and admission features of this extraction turbine increased the flexibility of both steam systems, since an outage of one of the larger boilers on the 250-psi system would result in a deficiency of 250-psi steam which would be supplied by extraction at the sixth stage of the extraction turbine. Conversely, if an excess of 250-psi steam occurred with an 850-psi unit down, the steam could be admitted to the later stages of the machine and converted into power. With all of this equipment installed, the fuel system including steam and power would be balanced to a point that we were using all by-product fuels available.

A condensed version of this "Fuel and Power Survey" is shown on Figure 1. In this figure all of the fuels have been converted into Btu per hr. Starting at the left 1,660,000 gal of pitch per month, amounting to 380,000,000 Btu per hr, would be reserved for open hearth, as outlined before, along with the coke oven gas which had been desulphurized. Any additional fuel after all of the coke oven gas was used up in the open hearth would have to be oil. In the next column "coke oven gas" the total supply of 4,360,000 cfhr, equivalent to 2,300,000,000 Btu per hr, would be used as shown, 813,000 cfhr for underfiring three coke oven batteries, 2,447,000 cfhr for open hearths and 1,100,000 cfhr for the mills. In the column titled "Mills," the coke oven and blast furnace gas would be used on the blooming mills and all the remaining fuel would be purchased fuel in the form of oil. In the next column "Blast Furnace gas," after the stoves, engines, mills and coke ovens

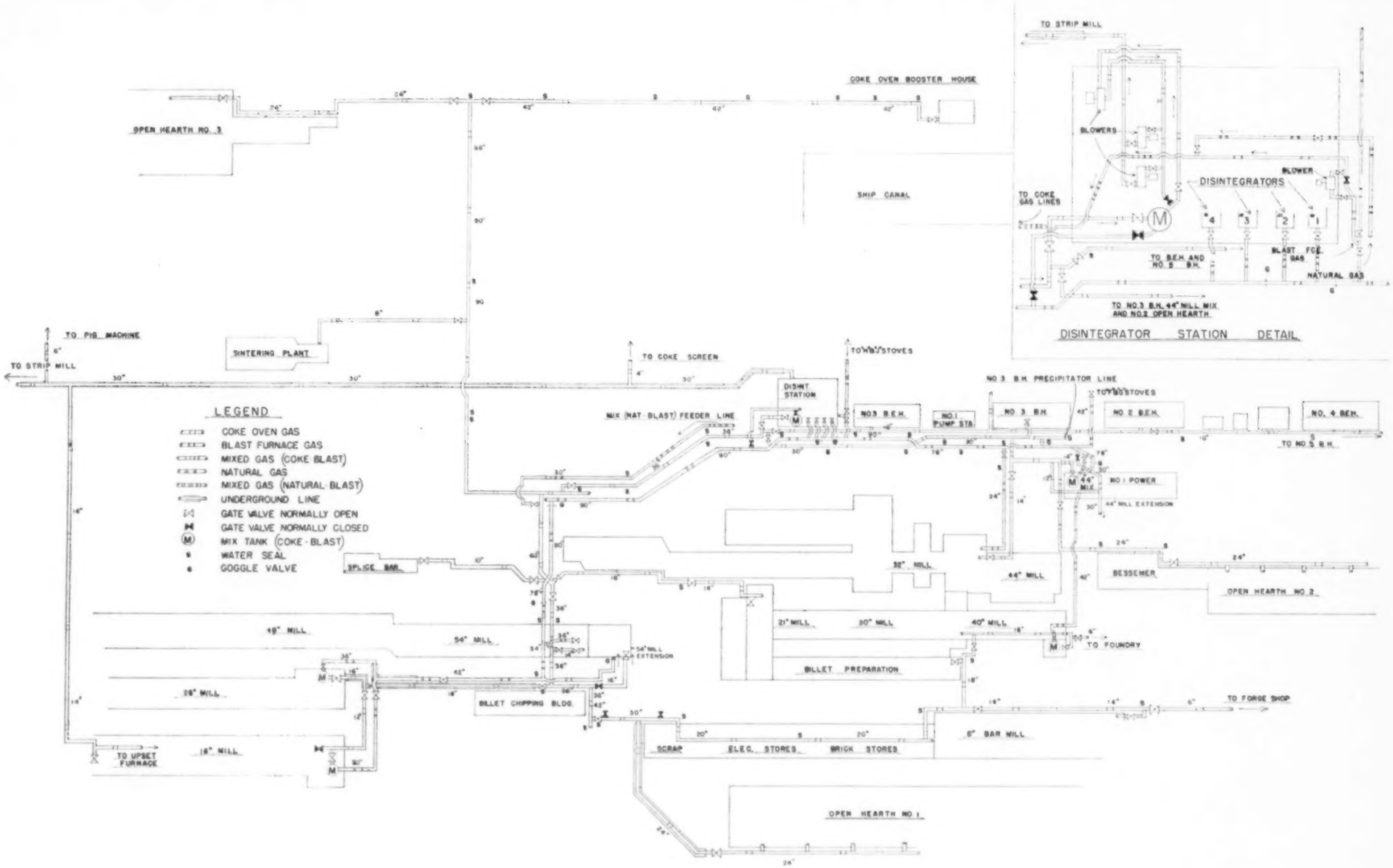


Figure 2 — Sketch shows both high and low pressure coke oven gas system.

were satisfied, over 18,000,000 cu ft of blast furnace gas would be available for steam generation. Coke breeze would be allocated as shown; to mills for the purpose of making "bottom"; to the sintering plant, and the remainder for boilers. The last column, "Power," shows simply that we would make 58 per cent of the power required and the remaining 42 per cent would have to be purchased. This program means that in an integrated steel plant such as the Lackawanna plant, the total purchase of fuel in the form of oil, gas and power amounts to approximately 20 per cent of the total fuel used over and above that needed in the blast furnaces for conversion of iron ore to iron. The remaining 80 per cent of this fuel will be by-product fuel. In this overall program, fuel interchanges are possible in the open hearth by adding or subtracting gas-consuming units, using oil as replacement, and in the mills, by adding or subtracting oil or natural gas consumers and replacing them with coke oven gas. Another fuel interchange possible is in the coke ovens where we can convert from blast furnace underfiring to coke gas underfiring, remembering that the effect of the interchange will be felt in both fuel systems.

The right half of the figure shows the steam-power balance for the plant. By using all by-product fuels, 1,685,000 lb of steam per hr would be made in the main plant, and an additional 175,000 lb per hr in the strip mill boiler house which is a separate system. Of this total amount made, 340,000 lb per hr would be made using waste heat from the open hearth as the fuel, the remainder with blast furnace gas and coke breeze. This would be consumed as shown, using 430,000 lb per hr for mills, heating, pumping station and miscellaneous purposes; 752,000 lb per hr at the coke ovens, turbo blowers and boiler auxiliaries, and the remainder being converted into power. All of these calculations are based on full production, but will hold for curtailed production as long as the capacities of the plant are in good relation. Even if the production of a unit lags somewhere along the line, a good deal of latitude is possible due to fuel interchanges.

The control of these systems is not an easy task by any means. It involves first of all, fuel changes on the mills by adding or deleting gas-consuming units to compensate for major variations in the demand on the system, to insure sufficient pressure at all times for the consumer. This must be done carefully so that the change does not unbalance the system in the opposite direction. Furthermore, it must not be done too often in order not to disturb the heating practice of the particular mill. Generally speaking, the characteristics of the combined system and the load factors at the mills are such that they tend to equalize each other. However, when conditions are such that the system is out of balance, either too high or too low, fuel interchanges are used. As a secondary control to compensate for the minor changes in demand, we use an addition in the form of a limited quantity of natural gas. This can best be illustrated by the Figure 2. Here it can be seen that both the high-pressure system for the open hearth and the low-pressure system for the mills stem from a common source. The high-pressure compressor station is equipped with controls so that the four electrically driven compressors will control the discharge gas pressure up to 25 psi. In addition, a butterfly valve is provided which will be closed if the suction pressure approaches a point not considered safe for coke oven operation. These two devices act independently of each other.

The low-pressure booster station which gets its gas from the same source has the ability to compress this gas to a pressure of 75 in. of water with five compressors, of which three are variable speed. A small 28,000-cu ft holder, having a rise of 30 feet, rides the suction pressure line on the low-pressure system. This holder, because of its size, is not much of a reservoir. However, it acts as a gasometer regulator by closing a butterfly valve in the suction line to the machines whenever the pressure is below 14 in. of water, or by opening a bleeder when the suction pressure is such that the holder is full. On the low-pressure boosters a regulator, by controlling the speed of three variable-speed, steam-driven units, is used to reduce speed when the suction pressure is low, thus maintaining the suction pressure, or to control the discharge pressure of the units when the suction pressure is high.

Under normal conditions this system should operate between 40 and 65 in. of water. To help keep the system in balance, and to compensate for minor variations, natural gas is admitted automatically at any time the system pressure is below 50 in. water, and shut off when the pressure rises above 58 in. water. The amount of natural gas blended with coke oven gas is volumetrically controlled so that under normal operation a fixed amount of natural gas is used. Should the situation demand it, this can be increased. When an increase is called for, an amount of blast furnace gas is also admitted to stabilize the heating value of the gas. Using this "flywheel" for the low-pressure system, it also handles the small variations in the high-pressure system since they are both fed from the same source. Also, as local conditions require, an amount of natural gas is blended with coke oven gas at the strip mill and bar mills. With this system in operation we are able to handle all the small variations that occur in plant fuel loads.

The second condition — that of long term demands or larger variations than can be handled by natural-gas additions — can best be illustrated by a simulated schedule for mill operations, shown on Table II. A schedule similar to this is roughed out for the entire week, and a detailed schedule is planned daily in advance. This table shows an approximate demand for the day turn of 2,770,000 cu ft of coke oven gas per hour. Then with mills going off at 3:00 pm, the requirements would be curtailed to a point where considerable gas would be lost if the use of purchased fuel, such as natural gas and oil, were not curtailed. The interchange from natural gas and oil to coke oven gas in the annealing department and the 10-in. mill plus the addition of a consumer in the 32-in. mill would again stabilize the system with an approximate demand of 2,600,000 cfhr. At the end of the second shift more of the consuming units drop out of the picture. At this point there are no more mill consumers using coke oven gas which could be added to the system so that a battery of coke ovens which had been fired with blast furnace gas would be changed over to underfire with coke oven gas. The

TABLE II

Mill	Gas M cu ft	Coke oven gas			Blast furnace gas		
	Operating turns	Day	Middle	Night	Day	Middle	Night
44-In.	1-2-3	200	200	200	1,200	1,200	1,200
32-In.	- -3	.....	lite 50	80	.....	100	150
40-In.	1-2	200	200	100	1,000	1,000	500
54-In.	1	200	100	100	1,300	650	650
8-In.	.....	.....	.....	.....	.....	.....	.....
10-In.	1-2-3	Oil	150	150	.....	.....	.....
12-In.	1-2	150	150	.....	.....	.....	.....
14-In.	1-2	150	150	.....	100	100	.....
28-In.	1	250	.....	.....	400	.....	.....
Splice bar	1	20	.....	.....	.....	.....	.....
Strip slab	1	200	.....	.....	.....	.....	.....
Anneal	1-2-3	Natural gas	200	200	.....	.....	.....
Boiler	1-2-3	.....	.....	.....	14,000	14,950	16,700
Open hearth 18	1-2-3	1300	1300	1300	.....	.....	.....
Misc.–	.....	100	100	100	.....	.....	.....
Stoves	1-2-3	.....	.....	.....	5,700	5,700	5,700
Engines	1-2-3	.....	.....	.....	800	800	800
Open hearth Total mills	.....	2770	2600	2230	.....	.....	.....
Batteries	.....	510	510	750	5,100	5,100	3,900
Total					29,600	29,600	29,600

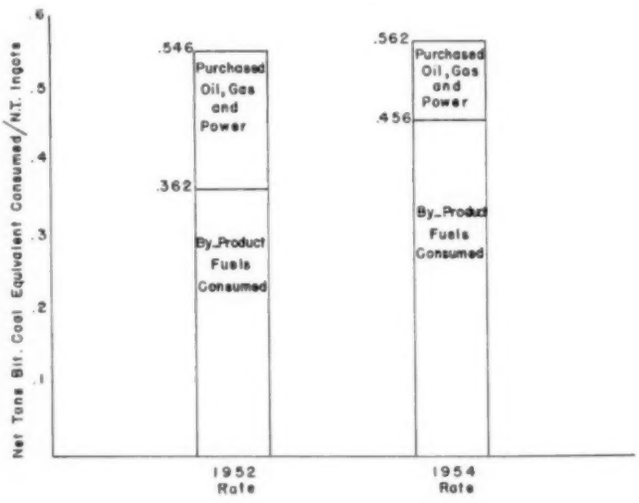
effect of this on the blast furnace gas system, as well as the other changes in the mill schedule, are shown in the right hand or blast furnace gas schedule. The additional blast furnace gas for the boilers would be reflected in increased power production, or, if we were generating all the power possible with the steam generating units, it would result in a decrease in the use of coke breeze. These schedules were made up purposely to show all of the variations that could be made in a day, and also to show the flexibility of such a system in times of lower than maximum operation. When curtailed operations require, mills can be scheduled on a staggered basis to afford the maximum flexibility and the best use of coke oven gas and to avoid, as much as possible, excessive fuel changes.

In the blast furnace gas system, the boilers, by manipulation of the blast furnace gas, coke breeze, and fuel oil firing, act as the "flywheel" on the system. With a reduction of blast furnace gas availability, the rate of burning coke breeze will be increased to the maximum possible, and this will be followed by fuel oil as required.

In order to supervise all of these systems and to order the necessary changes of fuel, a gas dispatcher is established in a suitable room with monitoring equipment such as total flow meters etc, to give him a picture of plant requirements. With the knowledge of fuels used in the various divisions and with the monitoring instruments to give him the flow and pressure to each of the coke oven gas systems, the blast furnace gas system and various other pertinent data, he is in a position to regulate all the required fuel interchanges.

The results of such a balanced system are shown in Figure 3. This figure shows the total fuel, over and above that used for fuel at the blast furnaces for the reduction of iron ore, required per ton of ingots at Lackawanna for 1952 versus 1954, based on the first 6 months of 1954. In January of 1954, the new steam generator was placed in service and since that time our fuel system has been in balance. The ingot production for 1952 was 3,607,540 net tons and based on the operation of the first six months of this year, the ingot rate for the year was 3,733,164 net tons. With the various systems in operation and under good control we were able to reduce the amount of purchased oil, gas and power from 0.184 net tons of bituminous coal equivalent per net ton of ingots in 1952 to 0.106 net tons per ton of ingots in 1954. It should be pointed out that the purpose of this figure is to bring out that in 1952, the amount of purchased power, oil and gas amounted to about 33 per cent of the consumed fuels, while in 1954, the purchased block amounts to about 19 per cent. It should also be pointed out that in 1952, the rate is actually on nine months of full operation because of the steel strike, while in 1954 the rate is on 70 per cent of full operation for six months. With this lower than full operation we were nevertheless able to hold the required fuels per net ton of ingot down to within a few per cent of the full operation requirements of 1952.

Figure 3 — Chart gives a comparison for the by-products fuels consumed and the purchased fuels per net ton of ingots at the Lackawanna plant.



DISCUSSION

PRESENTED BY

E. T. W. BAILEY, Chief Combustion Engineer, The Steel Co. of Canada, Ltd., Hamilton, Ontario Canada.

L. I. DICKINSON, Assistant Fuel Engineer, Bethlehem Steel Co., Lackawanna, N. Y.

E. T. W. Bailey: Like others, we are struggling with the same sort of problems. No sooner does one achieve some semblance of success, than some unexpected condition arises to upset the balance. Not only does one have to plan for seasonal variations due to building heating and higher radiation losses, but also the more serious fluctuations due to weekends, holidays and conflicting mill schedules. To make matters worse, studies have to be made to prepare for unbalanced operations such as 100 per cent blast furnace and coke oven operating capacity, while corresponding open hearth operation may be as low as 50 per cent. Mill furnaces do not reduce their hourly fuel rates, but rather reduce number of operating turns.

Our approach to the problem has been to equip open hearth furnaces with automatic controls to alter rates of coke oven gas, oil and steam flows, in accordance with gas availability. The controls have operated satisfactorily in the new furnace shop and are being extended to nine other furnaces. So far, use has been confined to the scrap melting period.

In the September 24th edition of the Iron and Coal Trades Review, Mr. W. B. Wright of Colvilles Limited, writes in part: "The heat input to the furnace was so arranged that during the charging period until the bath was flat, about 75 per cent of the heat was in the form of coke-oven gas, on the assumption that the heat transfer at this stage is principally by convection. After the bath was flat and the heat transfer is principally by radiation, the proportion of gas was reduced to about 60 per cent. During the final stages of the charge little oil need be used, the heat being carried mostly by the gas."

Do you finish heats with oil and gas and, if so, what percentage of the heat input is in the form of gas? Do you find there is a limit to the quantity of gas that can be used with pitch and, if so, what factor determines this limit?

In the case of slab furnaces, is the supply of coke oven gas desulphurized? If not, have you experienced shorter life of skids and cross pipes due to corrosion at the entry end? What is your estimate of reduced furnace capacity resulting from use of coke oven gas?

You are fortunate in having steam systems that allow use of an extraction turbine. This acts to reduce purchased power. We would have to install a condensing turbine and steam generator. The return on this investment for intermittent operation is not very attractive, as so much of the heat is absorbed in condenser cooling water.

I note you say frequency of fuel changes in the mills must not be excessive. What do you regard as excessive interference?

I also note the absence of the word bleeding. Can you go through a month without any bleeding?

L. I. Dickinson: In reference to your first question, gas has been used in conjunction with fuel oil to finish heats, but the combination of pitch and gas has proven our best fuel combination so far. We have found that during the early part of the heat, namely that period from the start of charging to the addition of hot metal, the gas may run as high as 80 per cent of the total fuel used. During the later parts of the heat, the gas is decreased and the liquid fuel increased, so that an average of 70 per cent gas and 30 per cent pitch seems to be the best use of gas with pitch.

In the case of the slab furnaces, the coke oven gas is not desulphurized, but we have experienced no particular difficulty with skid pipes or cross skids that have been attributed to the sulphur in the gas. As to any loss of heating capacity at the slab furnaces brought about by the use of coke oven gas, I can only say that we have broken production records with both fuels.

With reference to your question of fuel changes in the mills, we try to keep these changes over say 6 to 7 hours.

Your last question concerning "bleed" is an interesting one. No, we cannot go through an entire month without any gas bled, but actually using the fuel interchanges that we have, we only bleed 0.3 or 0.4 of 1 per cent of the total gas made.

WANTED!

There is a constant demand for copies of "The Modern Strip Mill," published by the Association of Iron and Steel Engineers.

If your copy is not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, November 28, 1955 — Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Welding and Cutting in Steel Mill Maintenance," by R. L. Deily, Steel Mill Representative, Air Reduction Sales Co., New York, N. Y.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, November 1, 1955 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Communication Equipment as Used in Modern Steel Plant," by E. J. McClure Jr., Power Foreman, Bethlehem Steel Co., Lackawanna, N. Y.

Hotel Sheraton, 715 Delaware Avenue, Buffalo, N. Y.

CHICAGO SECTION

Tuesday, November 1, 1955 — Dinner 6:15 P.M., Meeting 7:45 P.M.

"The Purchasing Story," by W. W. Crawford, Purchasing Agent, Electrical and Mechanical Equipment, United States Steel Corp., Pittsburgh, Pa. and J. G. Hepler, Assistant Director of Purchases, National Tube Div., United States Steel Corp., Pittsburgh, Pa.

Phil Smidt's Restaurant, 1205 North Calumet Ave., Hammond, Ind.

CLEVELAND SECTION

Data not available.

DETROIT SECTION

Tuesday, November 8, 1955 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Electric Systems and Drive Selections For Hot Reversing Mills," by C. C. Thomas, Group Engineer, Steel Mill Engineering Section, General Electric Co., Schenectady, N. Y.

Horace Rackham Educational Memorial Building, Detroit, Mich.

LOS ANGELES SECTION

Monday, November 14, 1955 — Dinner 7:00 P.M., Meeting 8:00 P.M.

"New Approach to Open Hearth Maintenance," by W. T. Purvance, Works Engineer, Columbia-Geneva Steel Div., United States Steel Corp., Geneva, Utah.

Rio Hondo Country Club, 10627 South Old River School Road, Downey, Calif.

PHILADELPHIA SECTION

Saturday, November 5, 1955 — Dinner 6:00 P.M., Meeting 7:00 P.M.

"Extensions to Sparrows Point's Industrial Water Supply," by Frank R. Hauser, Water Engineer, Bethlehem Steel Co., Sparrows Point, Md.

"Central Maintenance Operations and Control at Fairless Works," by R. L. Leventry, Division Superintendent of Maintenance and Utilities, United States Steel Corp., Fairless Hills, Pa.

Engineers' Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Monday, November 14, 1955 — Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Modernization of A1 44-in. Blooming Mill, Jones and Laughlin Steel Corp.," by A. B. Millman, Assistant Superintendent of Maintenance, Jones and Laughlin Steel Corp., Aliquippa, Pa.

Alumni Room, University Club, University Place, Pittsburgh, Pa.

ST. LOUIS SECTION

Data not available.

SAN FRANCISCO SECTION

Tuesday, November 8, 1955 — Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Oil Heating and Transmission in the Steel Plant," by James C. Harris, Jr., President, Heat and Control, Inc., San Francisco, Calif.

Shattuck Hotel, Durant and Shattuck Streets, Berkeley, Calif.

YOUNGSTOWN SECTION

Monday, October 24, 1955 — Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Brass Hats Night

"Hey Buddy! You're Not Overlooked — You're Overpaid and Overrated," by Merrick Lewis, President, Alliance Machine Co., Alliance, Ohio.

Mahoning Country Club, Girard, Ohio.

Monday, November 28, 1955 — Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Design of Structures by Means of Electric Computers," by J. D. Rollins, Vice President Engineering, American Bridge Div., United States Steel Corp., Pittsburgh, Pa.

Mahoning Country Club, Girard, Ohio.

AISE PAPERS AWARD WON BY G. S. MICAN

▲ AWARDS for the prize winning AISE Kelly award papers were presented September 28 at the banquet held in conjunction with the annual AISE convention. Winner of the first prize was George S. Mican, division superintendent—structural, South Works, United States Steel Corp., Chicago, Ill., for his paper on "A New Theory of Hot Rolling."

This paper gives a fundamental analytical analysis of what takes place during the rolling operation. Information is given on the forces which act in the deformed material, and information is given on the flow of the material. A knowledge of these factors is fundamental for explanation of rolling operation and in the design of rolling mills.

Of more importance, perhaps, is that an understanding of the paper may be helpful in improving rolling operations. The paper was originally published in the May 1954 Iron and Steel Engineer. This is not the first time that Mr. Mican has won an AISE paper award. In 1950 he also won the first place award with his paper on "Deformation in Rolling."

The second prize winner was E. A. Vierow, superintendent, fuel and power department, Youngstown Sheet and Tube Co., Youngstown, Ohio, for his paper on "Metallic Recuperators in the Steel Industry" which was published in the August 1954 Iron and Steel Engineer. This paper discussed the application of two types of metallic recuperators for steel mill installations and shows how they could be used to give fuel economy and increased production.

The third place award went to E. T. Lorig, chief development engineer of United States Steel Corp., Pittsburgh, Pa., for his paper on "Application and Use of Self-Centering Rolls." This paper was published in the January 1954 Iron and Steel Engineer. Mr. Lorig also won the first place award in 1951 for his paper on "Automatic Self-Centering Rolls and Pulleys." The current award winning paper describes many ingenious refinements which have been developed in the application of self-centering rolls for the handling of strip.

Other papers which received honorable mention were by James A. B. Pinney of Alan Wood Steel Co., on "6900-Volt Power System Fault Relay Analysis," and by K. S. Kuka on "Control of Electric Power Systems in Steel Plants." Mr. Kuka is superintendent, electrical engineering and construction, Tata Iron and Steel Co., Ltd., Jamshedpur, India. Mr. Kuka has also received honorable mentions on several previous occasions.

The Kelly award carries prizes of $300, $200 and $100 for first, second and third place respectively. The award was established in 1943 to honor John F. Kelly, managing director of the AISE from 1917 to 1934, and to perpetuate the memory of his achievements in the advancement of the Association.

The award is made each year by the board of directors of the AISE upon the recommendations of the editorial and executive committees of the Association.

Rules of the award:

1. The award shall be given annually to the author of the paper, adjudged of greatest value in the advancement of engineering or operating practice in the iron and steel industry.

2. The entries for each judging shall be the papers published in the Iron and Steel Engineer during each calendar year, although some may have been presented at meetings in the previous year.

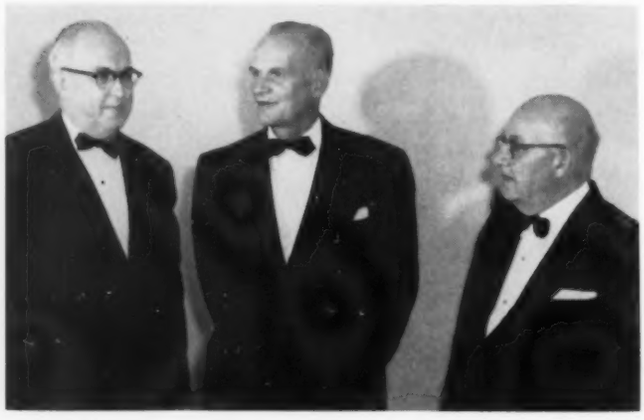
Voluntary contributions of papers not presented at meetings but published by the AISE are also included in the judging.

3. To be eligible for the award, the author must be directly employed in the iron and steel producing industry. The author need not be a member of the Association of Iron and Steel Engineers.

4. The award shall be made at the annual fall meeting following the close of the calendar year.

5. The award shall be made by the board of directors of the AISE on the recommendation of the executive committee of the AISE.

First prize winner of the AISE papers award, G. S. Mican (center), is flanked by second and third place winners, E. A. Vierow (left) and E. T. Lorig.



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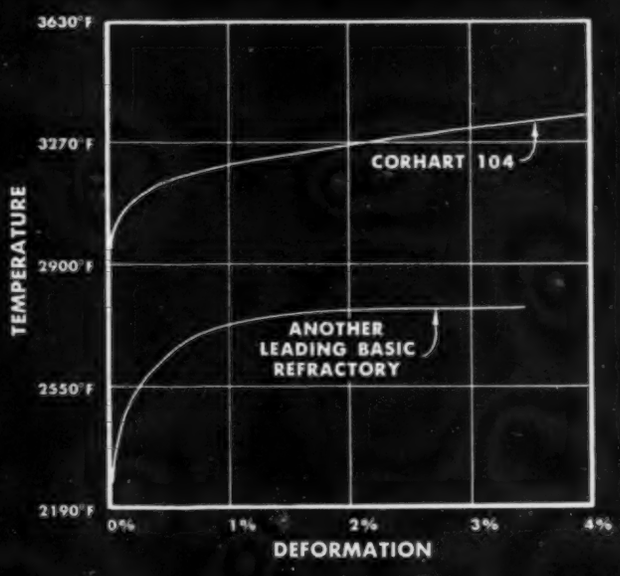

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COMPANY EXPANDS REFRACTORY CAPACITY

. . . . increasing requirements on the part of the steel industry, as a result of its efforts to raise production, requires also that suppliers expand their productive capacity . . .

▲ DURING 1951 and 1952, the tremendous expansion in the steel and other industries necessitated a corresponding increase in the output of refractories. To meet this need, Harbison-Walker embarked upon the greatest expansion program in the history of the company, costing more than $35,000,000. This program, which affected all of the company's products, included the construction of a new silica refractories plant at Windham, Ohio, and another at Fairfield, Ala. A new fireclay brick plant was erected at Fulton, Mo., and a basic brick plant at Marelan, Que. Other silica and fireclay brick plants were completely modernized and substantially enlarged. Plants at Baltimore, Md. and Warm Springs, Calif. have added greatly to their capacities to produce the basic refractories magnesite, chrome and forsterite. In 1954, the company purchased a large deposit of fireclay near Ohiopyle, Pa., and a plant at Grantsville, Md., for the production of fireclay refractories. Construction of a new plant for the manufacture of silica refractories at Leslie, Md. was begun in 1954 and completed early in 1955. In June, 1951, the company was operating 18 continuous tunnel kilns. The number has now increased to 29, with one additional kiln under construction at Marelan, Que.

NEW LESLIE PLANT

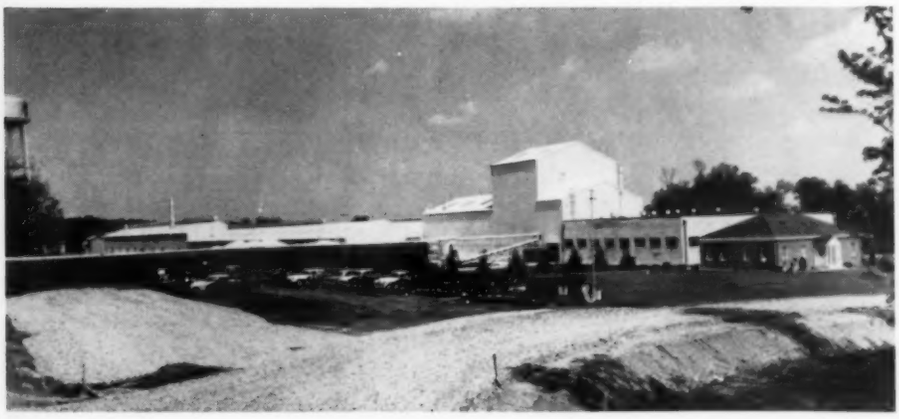
In the new Leslie plant, as at the new Windham, Ohio plant, two types of silica refractories are manufactured, Star brand of the conventional class and Vega brand of the superduty class. These products are used in by-product coke ovens, open-hearth and electric steel furnaces, glass tanks and furnaces of many kinds employed in the refining of copper and other non-ferrous metals.

The plant site was carefully selected for its closeness to raw material and to important consuming industries. The raw material originates in a quarry within a few miles of Leslie. The consumers are mainly located in the vicinity of Baltimore, Eastern Pennsylvania, and other points near the Atlantic Seaboard.

The plant is located approximately half way between Baltimore and Philadelphia and is well situated for both railroad and truck shipments.

The plant was completed in 1955. All engineering prerequisites were jointly determined by the operating, mining and engineering departments. The latest operating techniques and laboratory developments are incorporated in the operation without losing the advantages of latest improvements in machine design. The mechanical and electrical controls in every stage of the manufacture are simple and safe, and assure uniformity of product, maximum protection against occupational hazards and excellent working conditions.

Figure 1 — Exterior view of new Leslie plant shows grinding building and office in foreground.



MANUFACTURING PROCESSES

Leslie Works is the third silica brick plant built by Harbison-Walker since the Vega brand, a superduty silica brick, was introduced

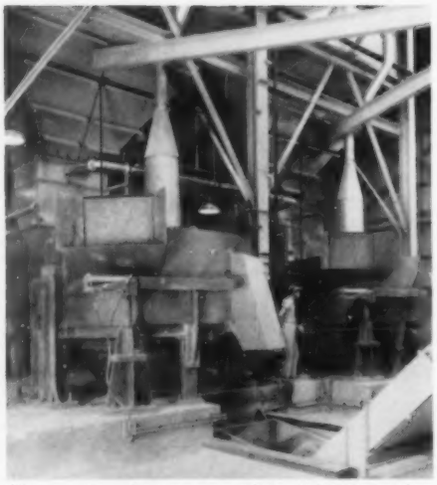


Figure 2 — Sequence of feed to the mixers is carefully controlled.

during World War II. This superduty silica brick can be manufactured at the same time as the conventional type Star silica brick. Although the greater portion of the brick are manufactured by the power press process, a part of the production is manufactured on a machine of the company's own special design —the impact press.

Grinding—The raw material is fed by an apron feeder and belt conveyor to a totally enclosed dry pan grinding mill. The product from the grinding mill is separated by an electrically vibrated screen into several size fractions as dictated by the particular mix required. The sized material is distributed by rubber lined chutes or conveyors to the various compartments of the ground material bins. A portion of this material is fed to a ball mill by means of a constant weight feeder for fine grinding. The ball mill is controlled by an electric ear and delivers its material to the fine ground material bins.

The dry pan, ball mill and material handling equipment is completely enclosed and connected to a bag type dust collector.

Batching—Two identical batching systems control the proportion of materials being readied for the mixing cycle. The coarser materials are withdrawn from the bins through cut-off gates into a sensitive weigh hopper and the fine materials are withdrawn by means of electrically operated rotary valves. This system is completely enclosed for control of dust and for best working conditions.

Mixing—From the weigh hoppers the various materials are introduced into two mixing pans of modern design, 9 ft in diameter, having a rotating pan and stationary mullers and scrapers. The sequence of feed to the pans is carefully controlled and the mixing time is very important in proper preparation of the material for molding. At the end of the mixing cycle, the contents of the mixers are discharged by means of disc emptiers into skip hoists which deliver the material to receiving hoppers above the presses.

Pressing—The power presses and the impact press may be fed either automatically or manually by means of carefully controlled reversible belt feeders from the skip hoist hoppers. It is possible by means of this system to feed the Vega or Star material used to any or all of the presses. A separate hopper over each press is of sufficient capacity to receive more than a skip hoist load thus allowing the mixes to be changed during operations. This hopper feeds each press by means of a belt feeder controlled by the quantity of material in a weigh hopper above the presses.

The pressed brick are delivered from the press by means of standard pushers or by mechanical pickers. The operator transfers the brick from the press to rack cars which in turn are handled by lift trucks operators to and from the rack car dryers.

Brick Drying—The rack cars loaded with brick are introduced into a dryer containing 6 tracks 125 ft overall length. After a car is placed in the dryer the train of cars is pushed hydraulically. The movement of cars through the dryer is in accordance with a carefully predetermined schedule. The dryer is supplied with clean hot air from the cooling zone of the kiln and a system of fans and ducts is arranged to insure a uniform movement of warm air throughout the complete cross-section of the six tracks. Both indicating and recording instruments are used to observe the temperature and humidity conditions throughout the length of the dryer.

Tunnel Kiln—This tunnel kiln is the seventh tunnel kiln built by Harbison-Walker for the burning of silica brick and is the 29th tunnel kiln to be put into operation in all the company's plants. The Leslie kiln is 504 ft long, holds 61 cars and has a load cross-section of 8 x 5 ft. The cars are pushed through the kiln continuously.

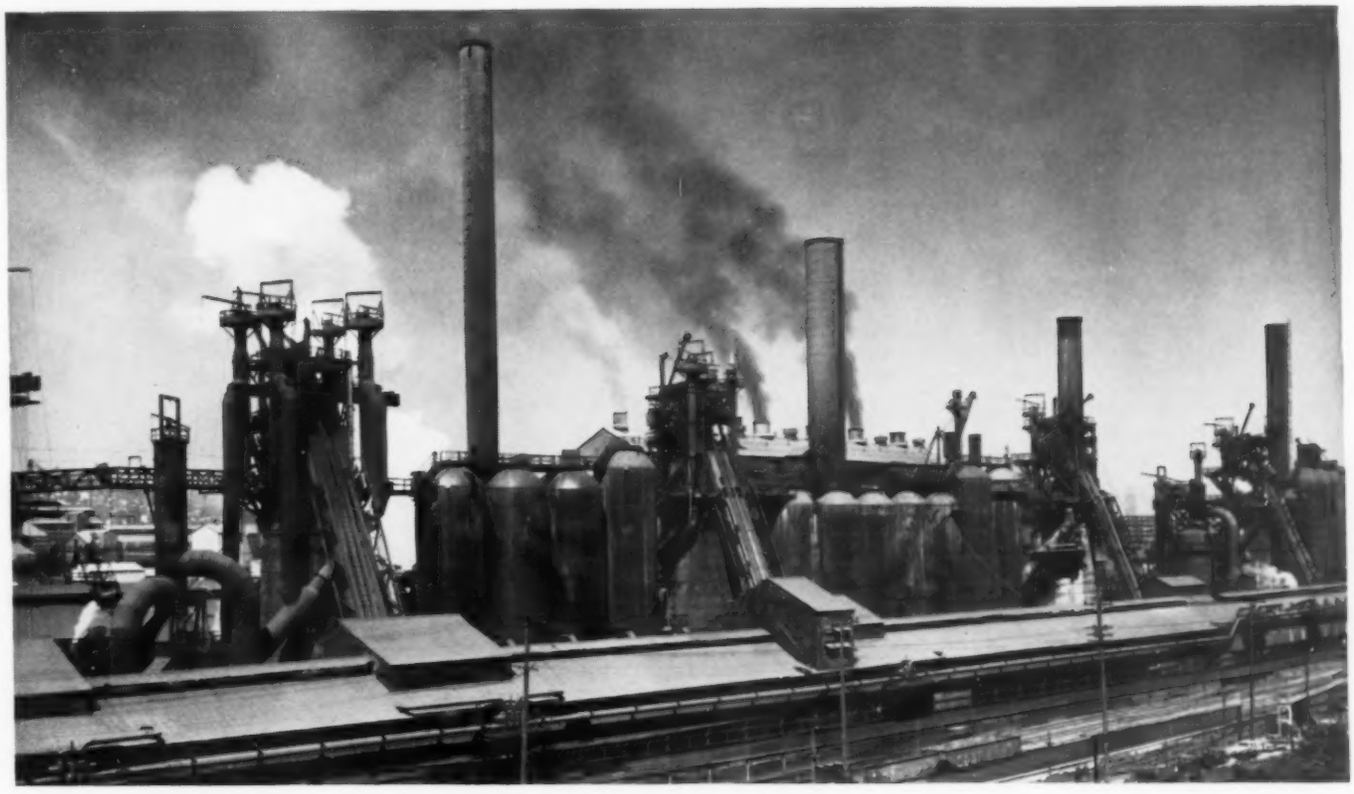
The kiln is equipped to burn heavy or Bunker C oil. The oil is heated by means of high pressure steam in the oil tanks and the oil lines are traced throughout the system by means of steam lines which are wrapped together and insulated. Hot air at approximately 700 F is delivered to the burners from the cooling zone of the kiln for combustion.

Groups of burners are zoned to

Figure 3 — Power presses may be fed manually or automatically.

Figure 4 — Tunnel kiln is 504 ft long. Discharge end is shown at right.

HOW DOWN TIME WILL DROP IN YOUR PLANT



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Take time today to see if HYATTS are being used for all roller bearing replacements in your plant. If not, take steps to see that HYATTS *will* be specified from now on. *They may help you save thousands of dollars every year!*

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allow for ready adjustment. The burners are designed to burn steam atomized Bunker C oil or air atomized No. 2 fuel oil. All of the air entering the burners must pass through the burner as the units are completely sealed against the introduction of free air from the room or the leakage of hot gases from the kiln if the kiln is being pressure fired.

For use in start-ups and for rapid recovery from work stoppages the kiln and boiler are completely equipped to burn No. 2 fuel oil contained in a 15,000-gal standby tank.

The kiln is carefully insulated to prevent excessive heat loss through the walls and crown and the insulation is varied to suit the temperature in any section of the kiln and still maintain an outside surface temperature of less than 200 F.

The entrance end of the kiln is equipped with a double door and vestibule system to prevent distribution of the draft during the charging operation. The kiln is charged at regular intervals — 24 hours a day, 7 days a week.

Both thermocouple and radiation pyrometer instruments are provided for measuring temperatures. These recording and direct reading instruments provide the information which permits the operator to set up any desired burning curve, and by adjustment of individual burners to secure uniform heating and cooling conditions throughout the length of the kiln.

Palletizing—Both the tunnel kiln cars containing unfired or green brick and those containing burned brick are handled throughout the plant by means of transfer decks and electrically driven locomotives. These d-c current driven units allow for speed variations within the widest possible practical limits.

The tunnel kiln cars containing the burned brick are delivered to unloading stations adjacent to the stock shed and the brick are unloaded at this point onto pallets handled by lift trucks. Through careful planning, the one-level plant provides for lift truck travel throughout, and permits easy handling of the palletized brick into storage, or delivery into railroad cars or trucks.

Dust Control and Collection—As in all of the modern silica brick plants, special attention has been paid to dust control. All of the equipment is completely enclosed and connected to a modern cloth bag-type collecting system which in turn discharges the dust into the Star ball mill fines bin. In addition, both for noise control and dust control, the grinding department is completely enclosed.

It is planned to install adequate high vacuum portable units for general and spot clean-up throughout the operation.

Quality Control—During the firing of silica brick, a permanent increase in dimensions occurs, amounting to about 15 per cent by volume. The expansion results from the transformation of the silica mineral quartz into other crystalline forms of silica. The completion and control of this expansion, without damage to the ware, requires extended time as well as careful temperature control, and this is the primary reason for the great length of the tunnel kilns in which silica brick are fired.

The thorough quality control program at Leslie is the same as that in effect at all other Harbison-Walker silica brick plants. At all stages of the manufacturing process, samples are regularly taken for immediate testing in the quality control laboratory. The brick are tested at the plant by competent laboratory technicians with complete laboratory facilities, and additional tests are conducted regularly at the company's central research laboratory at Hays, Pittsburgh, Pa. It was at this laboratory the refractories industry's first spectrograph was operated for control of the alumina and alkali content of silica brick.

Performance of Protective Coatings Checked by Tracer Techniques

▲ THE "eyes" of radioactive tracing technique were utilized to accomplish many important advancements as atomic research assumes an ever-growing role of importance as an invaluable right hand to industry. One of the latest and most unusual developments, incorporating radioactive tracing, was to actually trace the penetration of a fish-oil-based protective coating through rust to bare metal, after the coating had been applied directly over rusted metal surfaces.

It all started with the desire of the protective coating manufacturer, who wanted to actually show how his product penetrated through the rust to bare metal when applied over rusted surfaces. As a result, the development of a method to determine the degree of penetration of a fish-oil-based protective coating into rust on steel specimens, was the problem that the Rust-Oleum Corp. placed in the hands of Battelle Memorial Institute technologists in Columbus, Ohio.

Radioactivating test batches of the primer coating with C^{14} radioisotope, then applying the radioactivated coating to rusted test panels, and finally, lapping the coated test panels at 0.5 mil layers and taking radioactivity measurements at each level did the trick. However, behind this method and the results which were obtained, is a story of nearly three years of continued research. First, it was necessary to identify one or more of the major chemical constituents in the fish-oil-based vehicle of the coating. Second, this constituent was synthesized, using radioactive C^{14}. Third, the C^{14} labeled constituent was added to the fish-oil-based vehicle making it radioactive. The radioactive vehicle was then processed by the manufacturer into a radioactive coating

Left — Heavy, felted asbestos walls are applied over and under the varnished cambric tapes . . . then thoroughly impregnated . . . *Right* — then the impregnated asbestos is compressed to a dense, homogeneous wall that ensures long cable life.

look beneath the braid

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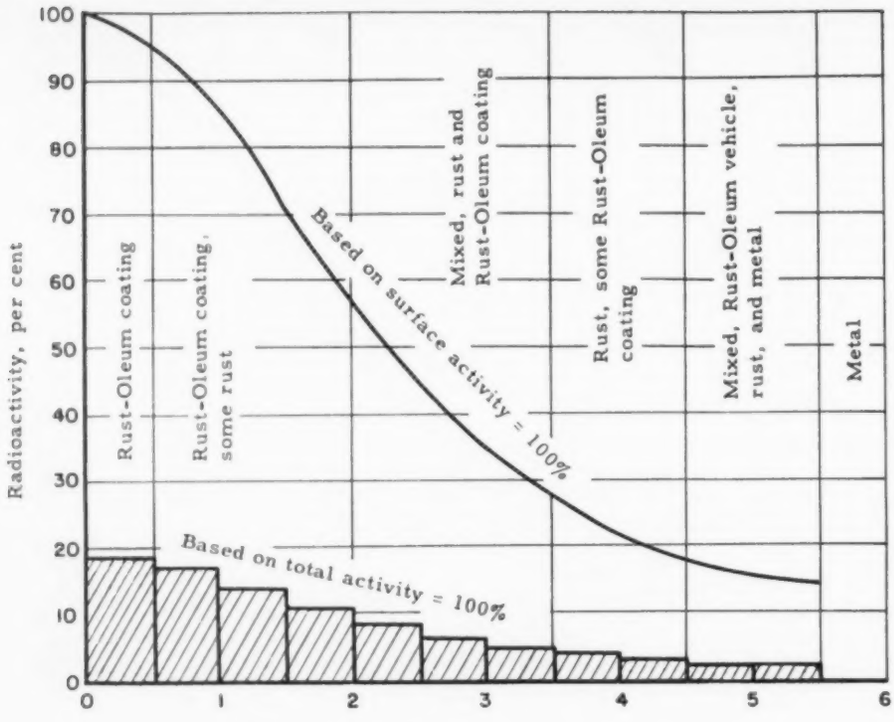


Figure 1 — Composite curve shows penetration of radioactive vehicle component of protective coating into rust layers of steel.

Figure 2 — Cross section of rusty steel, $\frac{1}{16}$-in. thick, with radioactive protective coating. (Magnification about 75X.)

equivalent to the manufacturer's standard product. Fourth, the radioactive coating was applied to rusted steel test panels and allowed to dry for two weeks. Fifth, the coated test panels were shaved downwards from the surface at 0.5 mil intervals and radio-activity measurements taken at each level down to bare metal.

Lengthy research alone was devoted to examination of the fish oil vehicle to determine which components would be most suitable for radioactive tracer synthesis studies. It was found that a major component, common to all fish oils, is glycerol in the form of triglycerides. The glycerol portion of the fish oil was then replaced by C^{14} labeled glycerol.

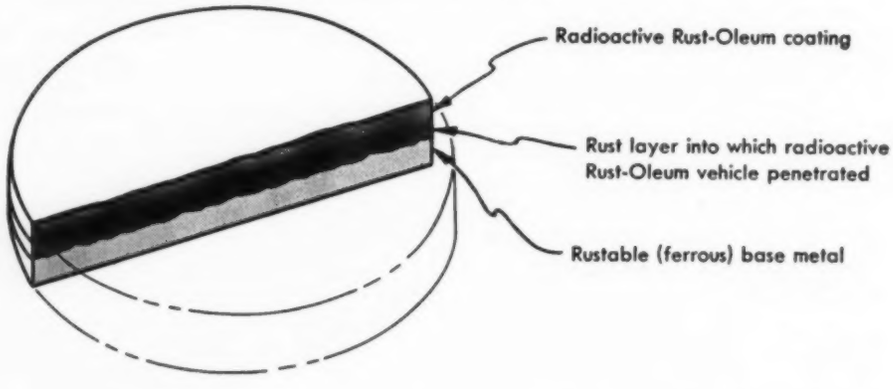
Equally important was the extensive testing and evaluating devoted to establishing that the re-constituted fish oil was identical in every way to the original oil. In addition to months of laboratory testing, the manufacturer conducted exhaustive tests in laboratory weatherometers and in the extremes of atmosphere exposure areas throughout the country to be sure that the synthetic procedures used in the research to radioactivate the fish oil did not change standard product performance.

After more than one year of testing the radioactivated coating, the procedures to measure the penetration through rust were started. To actually determine the degree of penetration of the coating into rust, seven badly rusted steel test panels were used with complete logs maintained on each specimen. These test panels were scraped and wirebrushed in conformance with the coating manufacturer's standard directions for application. The radioactive primer was then brushed on directly over the sound rusted surfaces and allowed to dry for two weeks. Following this, the coated test panels were placed in a lapping fixture that made possible controlled removal of the surface layer using crocus cloth as an abrasive. The surface was then lapped at an approximate 0.5 mil levels down to the bare metal surface and the radioactivity in the coating measured at each level by Geiger-Mueller tube and gas flow proportional counter.

The results, as carefully recorded by Geiger-Mueller tube and gas flow proportional counter, show that the protective coating does penetrate through the rust to the bare metal with approximately 15 per cent of the surface radioactivity being found at bare metal. Also revealed was the fact that the coating pigment and fish oil vehicle combined penetrate to about 4.5 mils in depth. From there the fish oil vehicle alone penetrates through the remaining rust to the bare metal surface at approximately 6.0 mils distance from the coating surface. Results also showed the unusual affinity which fish oil has for rust. For example, where rust had formed in deep pits or pockets in the bare metal, very definite radioactivity was recorded even at that depth.

A copy of the thirty-page report on Rust-Oleum penetration as prepared by Battelle Memorial Institute technologists, may be obtained by request on business letterhead to the Rust-Oleum Corporation, 2799 Oakton Street, Evanston, Ill.

Figure 3 — Illustrative cross section shows specimen with coating and penetration of coating. (Magnification about 75X.)


Radioactive Rust-Oleum coating
Rust layer into which radioactive Rust-Oleum vehicle penetrated
Rustable (ferrous) base metal

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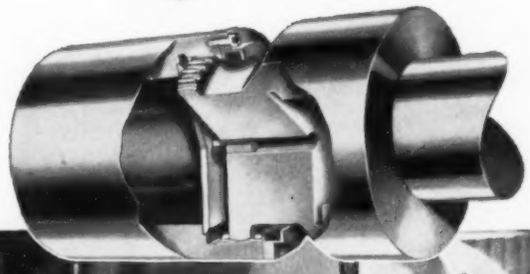

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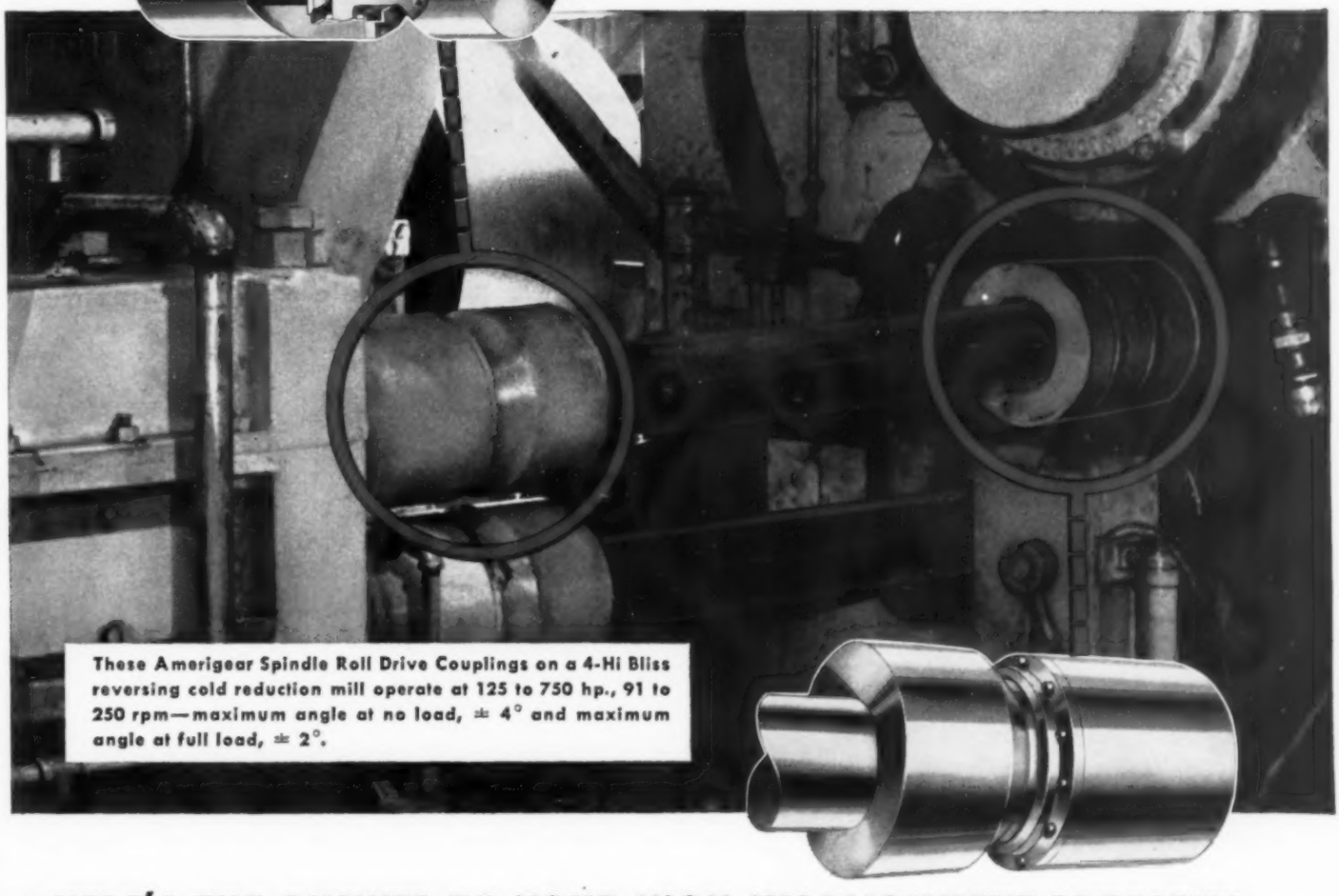

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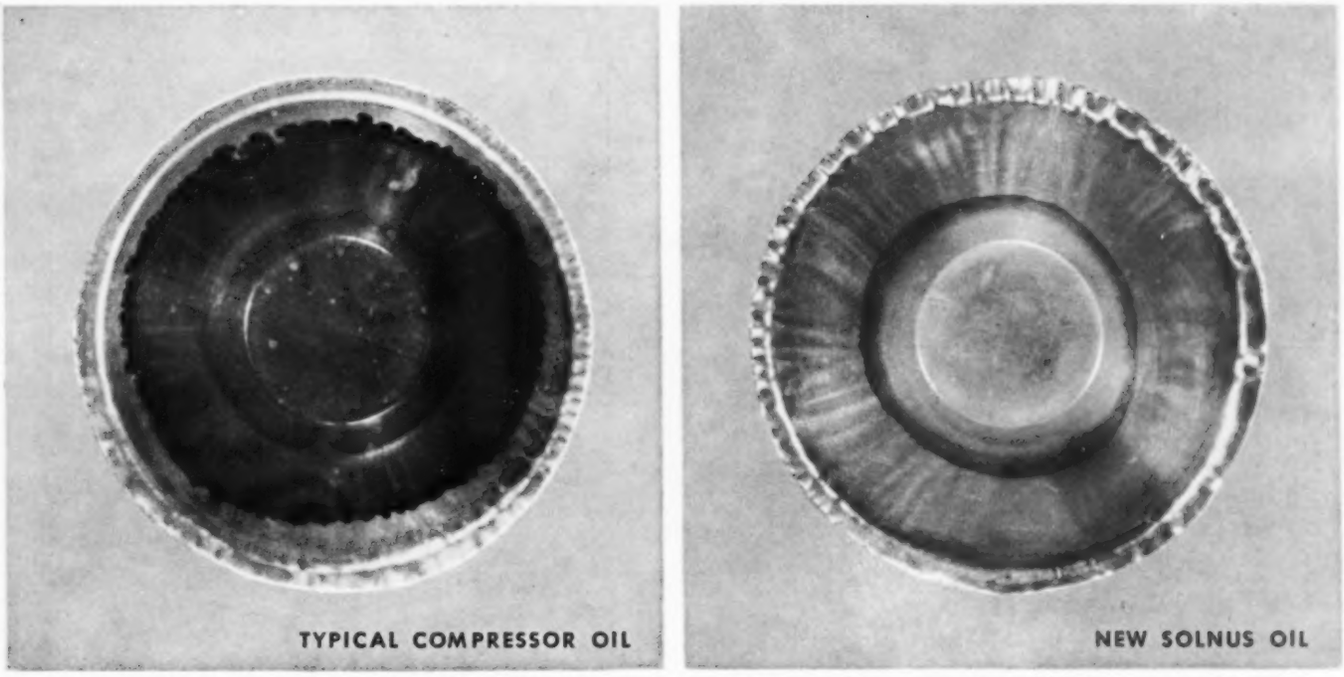

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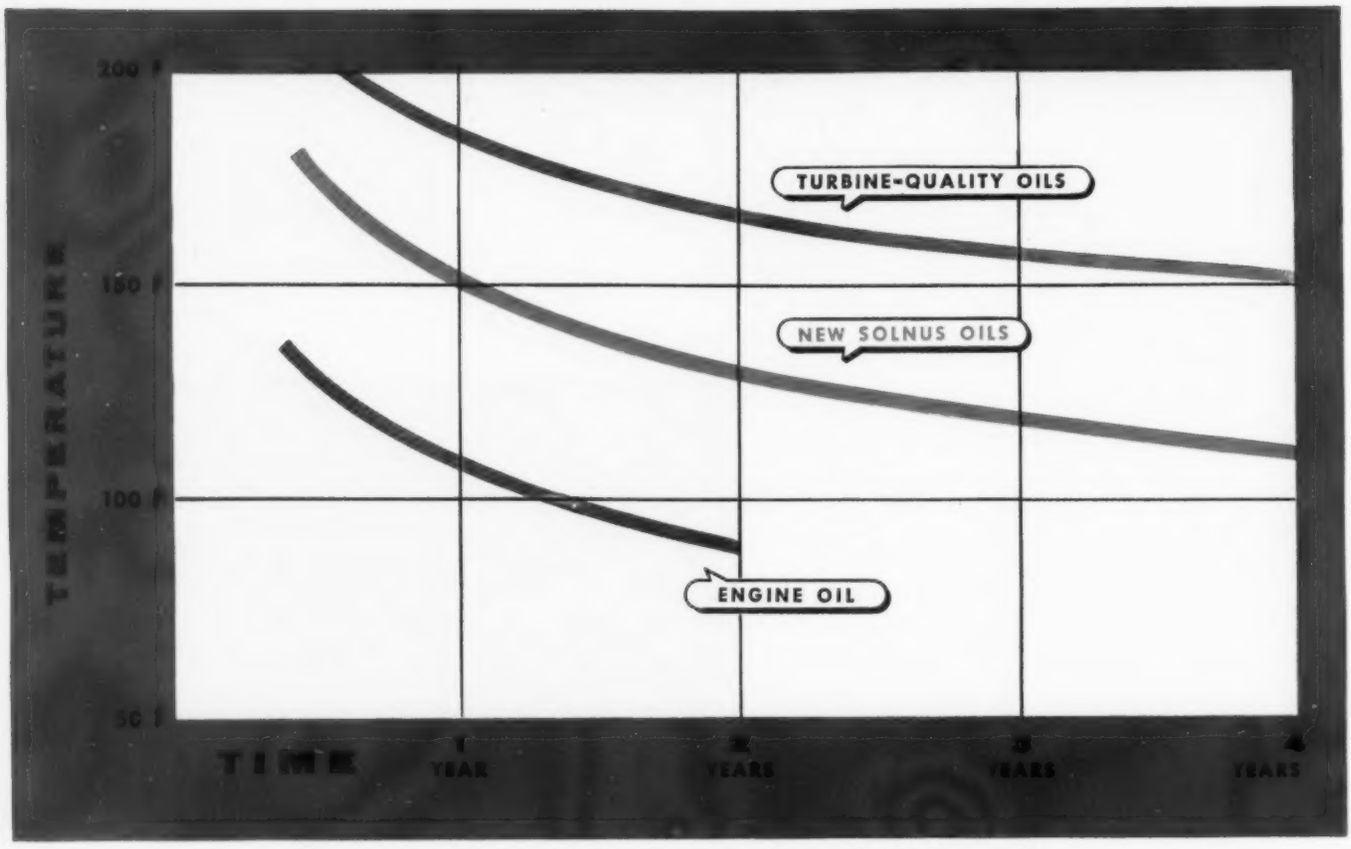
INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY PHILADELPHIA 3, PA.

IN CANADA: SUN OIL COMPANY, LTD., TORONTO AND MONTREAL



This graph is based on 10% make-up per year and a 40-hour week.
The yellow area represents approximately 80% of all applications.

NEW SOLNUS OILS IDEAL LUBRICANTS FOR 80% OF ALL APPLICATIONS

High grade lubricants for squirt-can prices . . . New Solnus oils give more lubrication per dollar

The lubricated parts of most machines—our estimate is 80%—operate at temperatures below 130 F and the time between oil changes is less than 2 years. New Solnus oils were specifically developed to meet these operating conditions at the lowest possible cost.

The above graph compares the service life of new Solnus oils with that of an expensive, turbine-quality oil, and an oil of the type old-timers call "engine oil". The service life of the turbine-quality oil is excellent and probably covers 99% of all applications . . . but for a premium price! The engine oil has a very limited life. It cannot be used safely, except for a very short time, at even moderately high operating temperatures, and it gives very little protection against rust and corrosion.

Now look at the service life of new Solnus oils. They easily meet the service requirements of at least 80% of all oil lubrication jobs and they sell for a squirt-can price! In addition, new Solnus oils are fortified to prevent both rust and oxidation . . . a feature usually found only in more expensive oils.

For the full story on new Solnus oils, see your Sun representative or write Sun Oil Company, Philadelphia 3, Pa., Dept. SI.

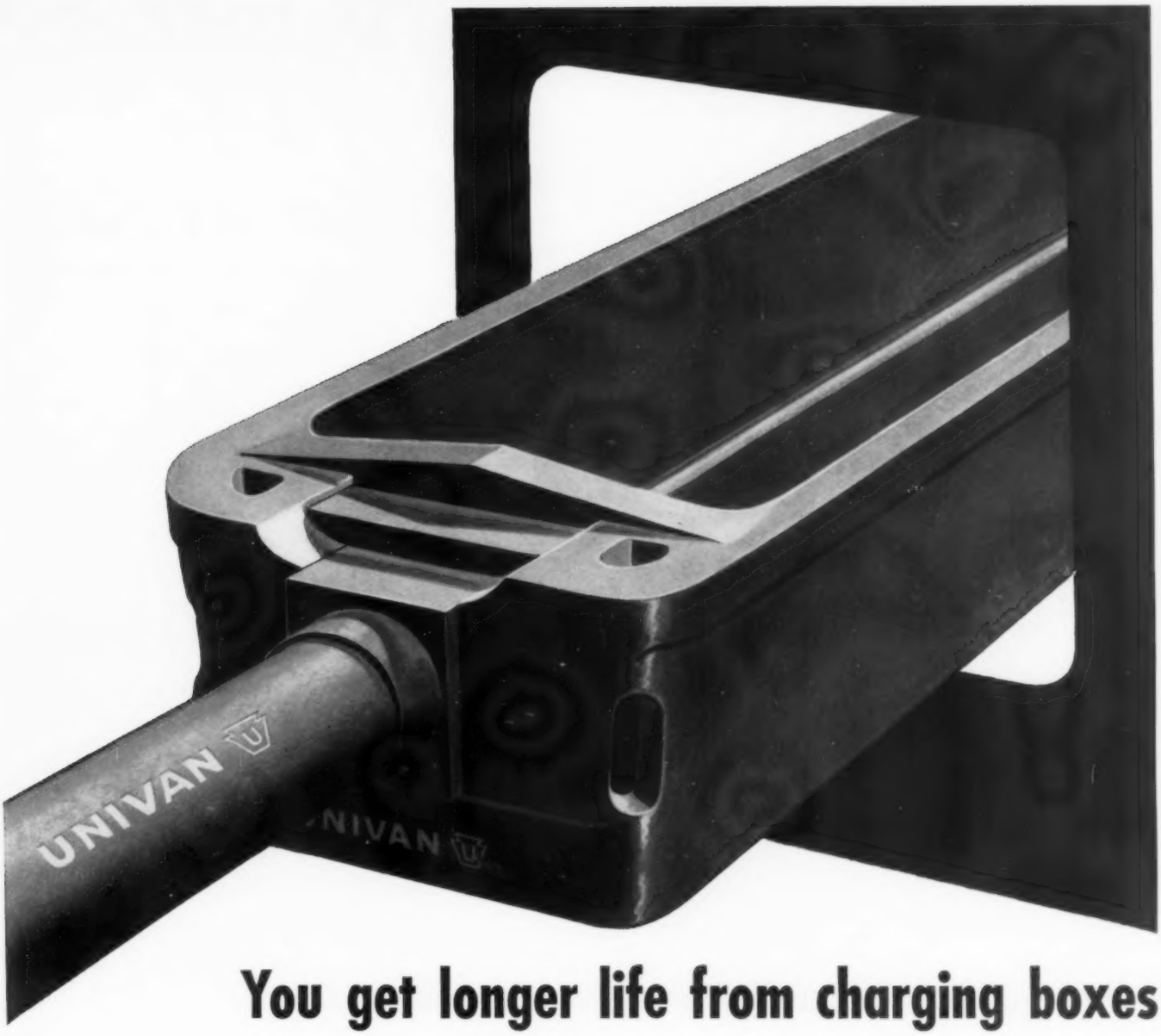
SUNOCO

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

PHILADELPHIA 3, PA.

In Canada: Sun Oil Company, Ltd., Toronto and Montreal



You get longer life from charging boxes and peels cast in nickel UNIVAN steel

This special alloy steel has definite advantages over carbon steel. Due to its nickel content, for instance, UNIVAN has greater resistance to firecracking. And its high tensile strength provides greater resistance to torsional twist and shock.

So, if you're having trouble with excessive firecracking, distortion or breaking of your present castings, UNIVAN castings may be the answer to your problem—whether they be charging boxes, peels, bearing covers, couplings and spindles, tongs and tong levers.

We'll be glad to give you more information about the performance of UNIVAN castings on the toughest jobs. Or, if you want prompt service, just send us your blueprints for a quotation.

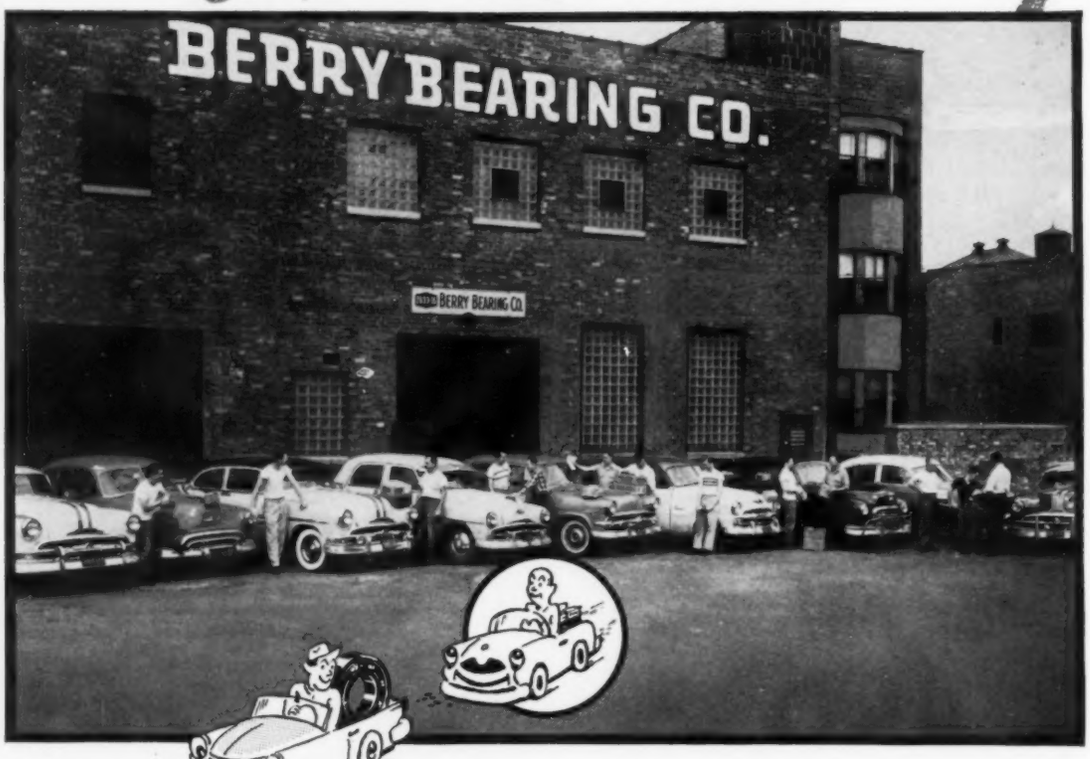
BLAW-KNOX

BLAW-KNOX COMPANY

Union Steel Castings Division . Pittsburgh 1, Pennsylvania

UNION PRODUCTS: charging boxes • peels • bearing covers • slag pots • tongs and tong levers • universal couplings and spindles • gears and pinions • ingot cars • charging box cars • special UNIVAN and ARMOR steel castings

Bearings Via BOULEVARD DELIVERY * give you Super Service Plus



BOULEVARD DELIVERY is a Berry Bearing Company innovation designed to transport bearings to your plant--in the minimum amount of time. A whole fleet of passenger cars is used. They by-pass congested traffic lanes...and...travel over thru-streets and boulevards. Thus, you get your bearings--in the shortest possible time. And, with one of the largest and most diversified stocks, Berry can immediately supply practically ANY type, size, or brand of bearings you need. They'll come via Boulevard Delivery. So, you'll get Super Service Plus--on every order.

BERRY BEARING COMPANY

All phones--DA nube 6-6800

2633 S. Michigan Ave. • • • • Chicago 16, Illinois

ANTI-FRICTION BEARING DISTRIBUTORS ASSOCIATION — MEMBER AFBDA

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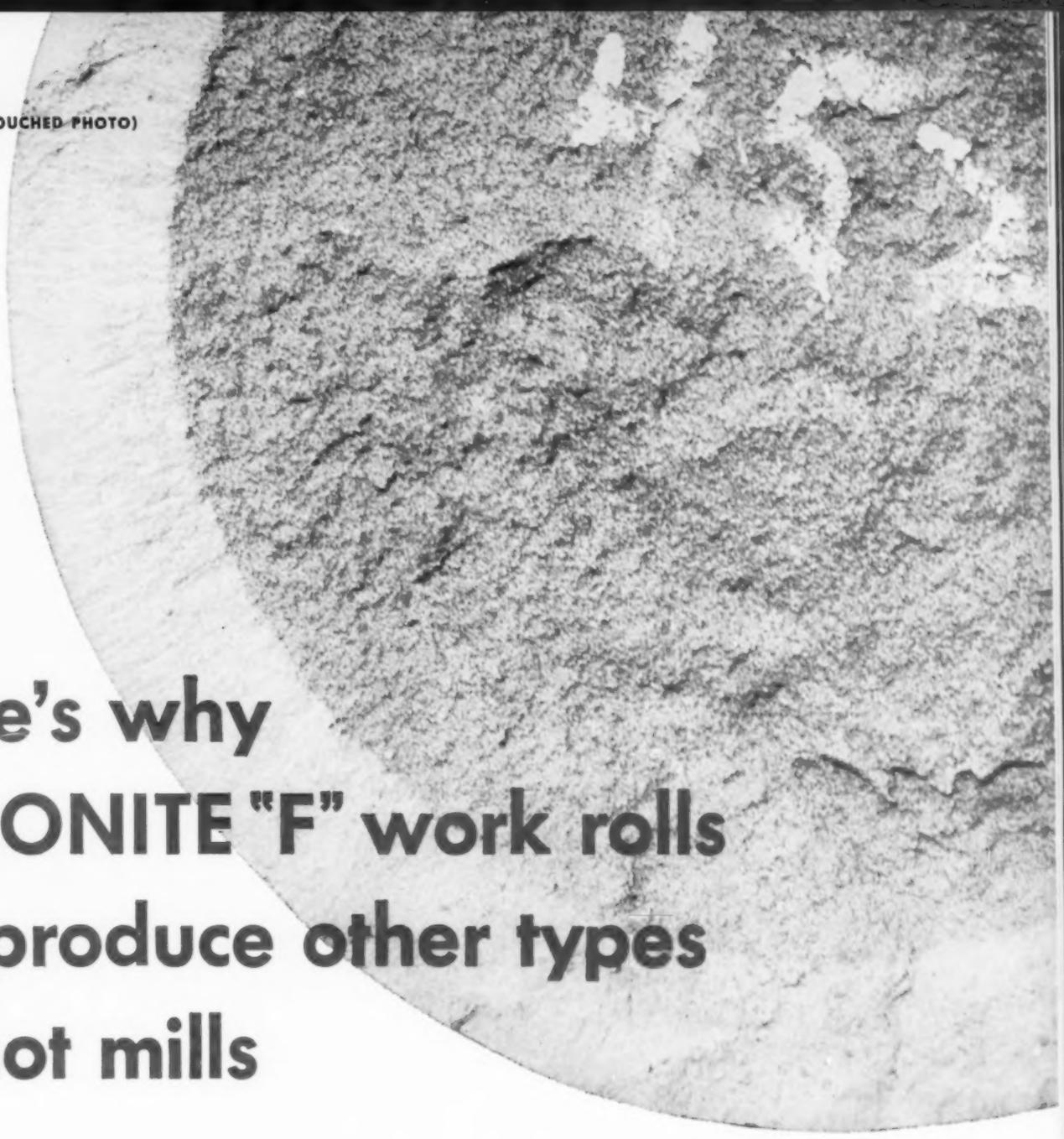


(ACTUAL UNRETOUCHED PHOTO)

Here's why NIRONITE "F" work rolls outproduce other types in hot mills

Take a look at the close grain structure and deep shell of this test-fractured 21" diameter Mack-Hemp Nironite "F" work roll. You can actually *see* why Nironite "F" rolls give you greater tonnages between regrinds . . . why they offer greater resistance to banding... why they last all the way to worn-out diameter. So distinctive is this close grain structure that mill operators report that they can recognize Nironite "F" rolls by the continued good roll surface even after long use—whether or not they have seen the stripes on the wabblers.

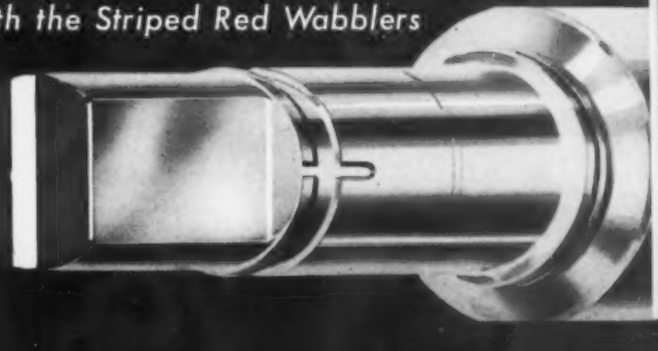
Nironite "F" rolls are high-nickel, high-chromium alloy grain type, double poured for maximum strength. They can be supplied in any desired hardness from 65 to 85 Shore scleroscope (C Scale).

Mack-Hemp offers an entire series of Nironite nickel-chromium cast iron alloys for 2-high or 4-high hot mill roughing, intermediate and finishing rolls. Your Mack-Hemp sales engineer will be glad to give you assistance in choosing exactly the right type and hardness for your particular rolling problem.

MACKINTOSH-HEMPHILL
DIVISION OF
E. W. BLISS COMPANY
Pittsburgh and Midland, Pa.

cast mill rolls • Johnston cinder pots
rotary tube straighteners • Y-type cold mills
heavy-duty lathes • end-thrust bearings
steel and special alloy castings

You get more tonnage from the rolls with the Striped Red Wabblers



Mr. T. V. Eppert points out the new Westinghouse Type SA (self-adjusting) D-C magnetic brake installed on bar transfer machine.

FACT:

Brake shoe adjusting eliminated with this new SA* motor brake

The self-adjusting feature of the new Westinghouse type SA, d-c magnetic brake in itself will bring your brake maintenance costs to their lowest levels. And that's just part of the story.

There are many added cost-cutting features of the type SA described completely in Booklet B-6548.

Get it from your Westinghouse sales engineer or write Westinghouse Electric Corp., 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pa.

J-21907

*** Self-adjusting**

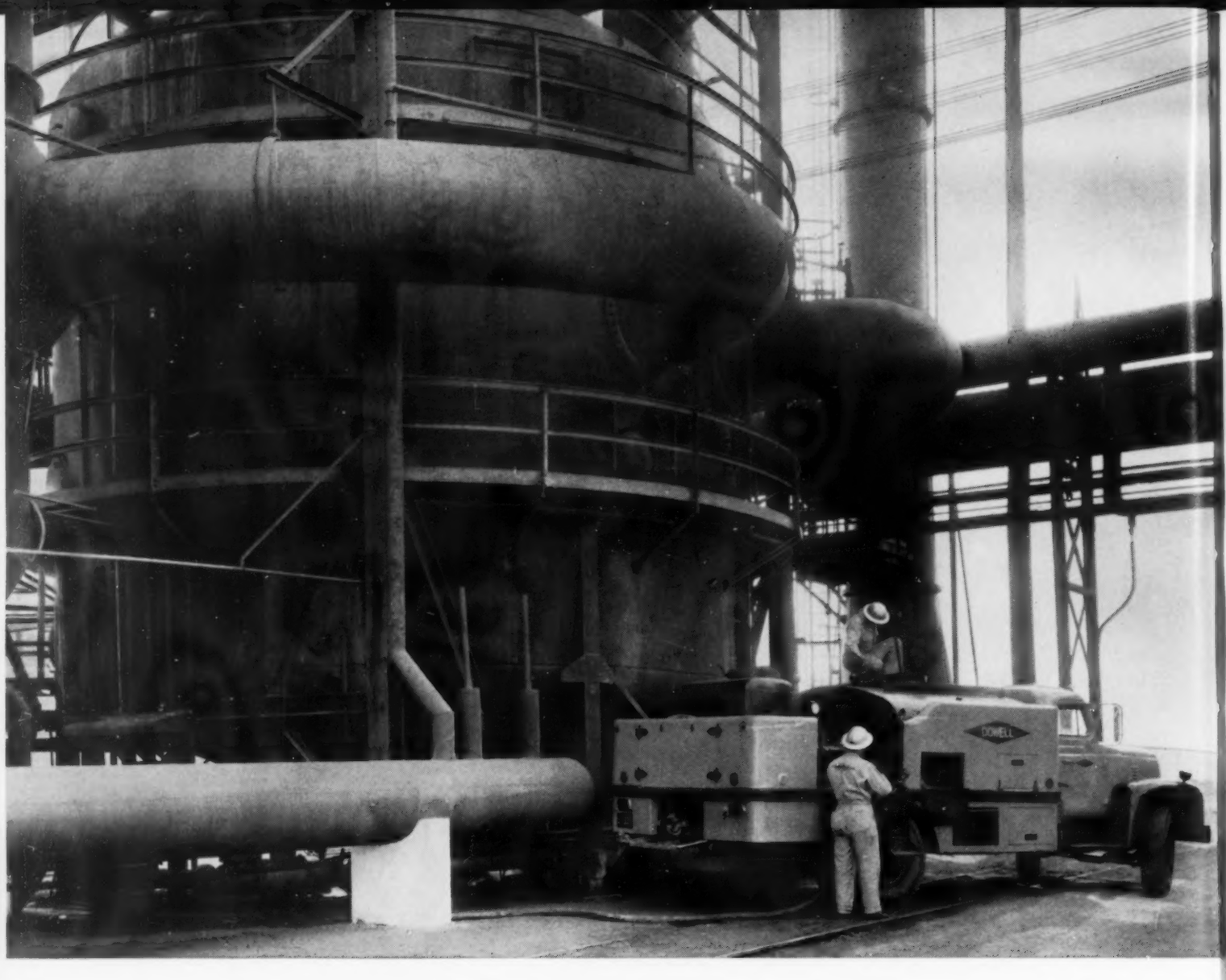
Lining life is increased because the self-adjusting brake shoe feature keeps both shoes in correct alignment with the wheel at all times. Shoe tips cannot drag—wheel scoring is minimized.

Magnetic housing is easily removed for coil accessibility. Coils can be repaired on the spot. No need to return them to the factory. Housing will hold either shunt or series coils.

Torque rating scale, stamped on spindle, takes the guesswork out of torque setting. Rated torque is factory-set and needs no changing. A clockwise turn reduces torque.

YOU CAN BE **SURE**...IF IT'S

Westinghouse



NO PRODUCTION SLOWDOWN DURING CLEANING

Without cutting gas output, DOWELL cleaned four precipitator sections chemically in only 15 hours—177 hours faster than mechanical cleaning

In today's steel plants, production schedules are more demanding than ever. Downtime may well spell the difference between profit and loss. That's one reason this operator was so pleased with Dowell chemical cleaning.

The operator had estimated that, using mechanical methods, it would take 192 hours to remove deposits from his four electrostatic precipitator sections. Dowell engineers, using chemical solvents, did the job in just 15 hours—saving 177 hours of valuable downtime. Inspection showed the sections to be free of scale and sludge. Moreover, no production was lost. Only a single section was taken out of service at any one time during the cleaning, allowing gas requirements to be met continuously.

With chemical cleaning, downtime is held to a minimum because solvents are introduced through regular connections. The liquid solvents used by Dowell go wherever water flows—cleaning all curves, angles and irregular surfaces.

Take advantage of Dowell's long experience in cleaning all kinds of industrial equipment. For full information call the nearest Dowell office—there are 165 in the United States and Canada. Or write to Dowell Incorporated, Tulsa 1, Oklahoma, Dept. J-29.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Date-line Diary...

September 2

▲ Zinc advanced ½¢ per lb to $0.13 per lb at East St. Louis.

▲ Wholesale sales during July dropped $500,000,000 from the June total but surpassed July of the previous year by over $100,000,000, according to the Department of Commerce.

September 5

▲ The AISI reports that operating rate of the steel industry for the week of September 5 is scheduled at 93.8 per cent of capacity. This is equivalent to 2,264,000 tons compared with 2,255,000 tons one week ago and 1,502,000 tons one year ago. Index of production for the week is 140.9.

September 6

▲ According to the Labor Dept., employment in August climbed to 65,500,000, setting a new high for the third successive month with a drop in unemployment of about 250,000 from the 2,500,000 in July.

September 8

▲ Republic Steel plans a $130,000,000 expansion program which will boost the capacity of this company by 1,600,000 tons annually or 16 per cent. The additions will be made at the Gadsden, Ala., and the Chicago, Cleveland, Youngstown and Warren, Ohio plants.

▲ Construction outlays in August rose to almost $4,000,000,000, up 1 per cent from July and 8 per cent above August of 1954.

▲ Personal income reached a new high of $304,700,000,000 annually during July as estimated by the Commerce Dept. This was $3,100,000,000 above the June rate and $17,600,000,000 above the July 1954 rate.

▲ Peacetime transportation needs will require improvements in railroads of at least $20,000,000,000 within the next ten years said James M. Symes, president Pennsylvania R. R.

September 9

▲ The cotton crop for 1955 was estimated at 12,873,000 bales by the Agriculture Dept., an increase of 145,000 bales over the month earlier forecast.

▲ Electric power output dropped last week to 10,706,000,000 kwhr or 200,000,000 kwhr below the preceding week but 17.8 per cent above the like week of 1954.

▲ Pig iron output in Canada jumped 33 per cent during the first half of 1955 to 1,521,580 tons from the 1,138,072 tons the year before. Production of steel rose 35 per cent to 2,108,928 tons from 1,555,097 tons the previous year.

▲ Kaiser Aluminum and Chemical Corp. filed with the SEC a registration statement covering 700,000 shares of $50 par value preferred stock. It is expected this stock will be offered publicly later in the month.

September 10

▲ The Aluminum Assn. reported primary production of aluminum in July totaled 265,337,163 lb in comparison with 255,265,003 lb the previous month and 252,323,794 lb in July of 1954.

September 11

▲ F. W. Dodge Corp. reports total contract awards for August for the 37 eastern states was $1,894,841,000, an all-time high, and 20 per cent higher than August 1954.

September 12

▲ The AISI reports that operating rate of the steel industry for the week of September 12 is scheduled at 95.1 per cent of capacity. This is equivalent to 2,295,000 tons compared with 2,264,000 tons one week ago and 1,583,000 tons one year ago. Index of production for the week is 142.9.

▲ Shipments of iron and steel castings during June amounted to 1,530,000 tons which was about equal to the May total and 32 per cent above the shipments in June of 1954, according to the Bureau of the Census, Dept. of Commerce.

September 13

▲ Business firms plan to spend $7,300,000,000 for new plants and equipment during the last three months of 1955 according to a recent government survey.

September 14

▲ The Harvey Machine Co. of Torrance, Calif. has secured authorization from GSA to build a $65,000,000 primary aluminum plant at The Dalles, Ore. The plant is expected to produce 108,000,000 pounds per year.

▲ Price of ferroalloys used by the steel industry to make stainless and other types of steel were advanced an average of 5.3 per cent by Union Carbide and Carbon Co.

▲ DuPont returned a certificate of necessity to the Government for a fast write-off on a $40,000,000 titanium plant near New Johnsonville, Tenn. This was the result of a study by the Government which showed that contracts will more than supply defense needs for the next two years. The plant will still be built, however, for commercial products.

▲ A new estimate by the Assn. of American Railroads shows that 1955 earnings are expected to be $1,040,000,000 compared with an earlier prediction in June of $973,000,000. Last year's figure was $875,000,000.

▲ Shipments of iron ore down the Great Lakes rose to 3,071,173 tons for the week ending September 12. This was a 60 per cent gain over the previous year's level.

▲ Copperweld Steel Co. plans a $12,000,000 expansion and modernization program of its steelmaking and steel-finishing facilities in Pittsburgh.

▲ According to the Mineral Industry Surveys, U. S. Department of the Interior, Bureau of Mines, consumption of ferrous scrap during July totaled 5,468,000 tons a decrease from the 6,117,573 tons consumed in the previous month.

September 15

▲ Copper consumers in private industry were allotted 11,000 tons previously slated for delivery to the national stockpile during the fourth quarter. The government also diverted 75,000 tons of aluminum to industry.

▲ Britain announced it will maintain the exchange value of $2.80 for the pound sterling.

▲ General Electric Co. predicts it will top their previous record year sales of $3,100,000,000 this year.

September 16

▲ Electrical workers at Westinghouse Electric hinted they will go after pay boosts of 18¢ to 22¢ per hr by the time their present contract expires on October 15.

▲ According to a report of the Lake Carriers Assn., iron ore shipments down the lakes totaled 13,572,266 gross tons during August, 42 per cent up from the 9,554,681 tons in August 1954.

September 19

▲ The Labor Dept. reported work starts on 123,000 new housing units in August, a gain of 8000 over the July figure.

▲ Defense officials will resume fast tax write-off allowances with around 38 major industries which had been recently cut off. This is about one-third of the suspended industries and the remaining two-thirds are still shut off.

▲ The Board of Directors of Blaw-Knox Co. approved an offer to purchase the assets and business of Continental Foundry and Machine Co. for about $25,000,000.

▲ According to the iron and steel division of the Business and Defense Services Administration, a steel expansion program with a goal of 150,000,000 ingot tons by 1960 should be encouraged through accelerated amortization.

▲ The ODM had authorized ALCOA, Reynolds Metal and Kaiser Aluminum to deliver 50,000,000 lb of aluminum to the General Services Administration in the fourth quarter of 1955. Twenty-two million lb of this will go to the United Kingdom under terms of an agreement in 1952 with the balance going to the stockpile.

▲ The AISI reports that operating rate of the steel industry for the week of September 19 is scheduled at 95.7 per cent of capacity. This is equivalent to 2,309,000 tons compared with 2,309,000 tons one week ago and 1,637,000 tons one year ago. Index of production for the week is 143.7.

▲ Deliveries of new domestic freight cars in August rose to 3480 compared to the 2192 in July and 2297 in August one year ago, according to the ARCI. August orders totaled 13,405 in comparison with 18,007 in July and 2425 in August one year ago. Backlog on September 1 stood at 52,803.

September 20

▲ The Industrial Heating Equipment Assn. reported that orders for furnaces during August totaled $6,273,053, an increase of 144 per cent over the August 1954 total of $2,570,761.

September 21

▲ Price increases ranging from $46 to $99 were placed by the Ford Motor Co. on the 1956 models.

▲ The Aluminum Assn. reported primary aluminum production in August totaled 267,101,817 lb in comparison with July's total of 265,337,163 and August of one year ago with 250,592,575.

September 22

▲ Tariff reductions were proposed on imports amounting to around $2,000,000,000 annually and affecting 800 items ranging from autos to Scotch whisky.

▲ The U. S. had a record loss of $799,000,000 in supporting farm prices during the year ending June 30, 1955.

September 23

▲ Defense Mobilizer Flemming announced that there will be no more fast tax write-offs for the aluminum industry and they will not be resumed for the steel industry.

September 26

▲ The AISI reports that the operating rate of the steel industry for the week of September 26 is scheduled at 96.0 per cent of capacity. This is equivalent to 2,316,000 tons compared with 2,320,000 tons one week ago and 1,678,000 tons one year ago. Index of production for the week is 144.2.

▲ Lead advanced ½¢ to 15½¢ per lb in New York, the first increase since last October.

▲ Revere Copper and Brass, Inc., Kaiser Aluminum and Chemical Corp., and Reynolds Metals Co. announced they would go ahead with their plans to build new primary aluminum production facilities in spite of the Government's refusal to grant fast tax write-offs on such plants.

September 27

▲ The AISC reports August bookings of fabricated structural steel amounted to 311,453 tons compared to 369,414 tons in July and a 61 per cent increase over the 193,081 tons in August 1954. Shipments in August totaled 266,715 leaving a backlog of work ahead as of August 31 of 1,775,625 tons.

▲ President Eisenhower's heart attack caused a big tumble in stocks with a drop of 6.54 per cent, the greatest drop since October 28, 1929.

▲ According to the Commerce Dept., consumers spent 94¢ out of every dollar for goods and services after taxes during the first half of 1955 as compared with 92¢ spent in the like period in 1954.

September 28

▲ The stock market rebounded quickly from the drop which occurred Monday with a gain of 2.27 per cent yesterday.

▲ The board of directors of the Texas Eastern Production Corp. and the Texas Eastern Transmission Corp. approved the proposal for the merger of the first with the second company. The stockholders will vote on this at a meeting scheduled for November 8.

September 29

▲ Rail freight volume during the fourth quarter will climb almost 25 per cent over the year earlier level in the Great Lakes area predicted the regional advisory board.

▲ Pennsylvania Railroad plans to revise its operating set-up by organizing nine separate regions, each headed by an independent regional manager.

September 30

▲ The Government resumed fast tax write-offs on commercial aircraft, electric power, freight cars and ocean tankers. It was discontinued permanently on other items such as gas and oil pipelines, tinplate, iron ore and airport facilities.

▲ Industry leaders expect machine tool orders booked during this year to reach $800,000,000 or more in comparison with a total of $560,000,000 reached last year.

▲ Installment credit outstanding during August increased $679,000,000 to a total of $26,200,000.

▲ Chrysler Corp. has announced it will start working soon on an $85,000,000 fabricating and stamping plant expansion in northeastern Ohio which is in addition to an expansion program announced by this company earlier in the year amounting to $125,000,000.

Q. Who's the world's foremost designer of sintering, pelletizing and related ore processing equipment?

A. LURGI-CHEMIE, a Frankfurt, Germany company with over 250 sintering machines in operation throughout the world.

Q. Is their equipment available in the United States?

A. Yes . . . DRAVO Corporation has exclusive license to manufacture and distribute DRAVO-LURGI ore agglomeration equipment in this country.

Q. Does it differ from that produced in Germany?

A. DRAVO-LURGI Machinery is an adaptation of the basic Lurgi design to meet American standards. Complete large-scale pilot plant testing facilities are available for determining process details accurately before actual installation.

Q. Can you give me more important technical details?

A. DRAVO can give you complete information on how this equipment can best serve your needs. Write today, outlining your agglomeration problem.

Dravo Corporation, Department E-1510
Fifth and Liberty Avenues
Pittsburgh 22, Pa.

☐ Please send me a copy of DRAVO-LURGI Bulletin No. 1503.

☐ Please have a representative call.

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FACTS ABOUT Exide®

IRONCLAD® INDUSTRIAL TRUCK BATTERIES

THE MORE YOU MOVE, THE MORE YOU SAVE... WITH EXIDES!

EXIDE-POWERED ELECTRIC TRUCKS WORK FULL-SHIFT WITH NO UNSCHEDULED DOWN-TIME. TRUCK OPERATION IS SMOOTH, SPOTTING IS PRECISE-WITH NO NOISE OR FUMES. BUT BEST OF ALL, THE MORE MATERIALS YOU MOVE, THE MORE SHIFTS YOUR TRUCKS WORK, **THE MORE MONEY YOU SAVE**-CONSIDERING EXIDE'S LOWER COSTS TO OPERATE, MAINTAIN AND OWN! YOUR EXIDE ENGINEER HAS A SLIDE CHART BASED ON THOUSANDS OF HOURLY COSTS FOR POWERING INDUSTRIAL TRUCKS. ASK HIM TO PROVE THAT EXIDE-IRONCLADS ARE **YOUR BEST POWER BUY- *AT ANY PRICE!***

TUBES OF POWER

INSIDE EVERY IRONCLAD ARE SLOTTED TUBES THAT KEEP THE ACTIVE MATERIAL IN FIRM CONTACT WITH CONDUCTING GRIDS OF THE POSITIVE PLATES. THE ELECTROLYTE FLOWS EASILY THROUGH THESE NON-CORRODING SLOTS TO REACH MORE ACTIVE MATERIAL FASTER. RESULT: AN IRONCLAD DELIVERS GREATER POWER... FOR A LONGER TIME... AT LOWEST COST!

® PROTECTED SILVIUM CONDUCTING GRID
COMPRESSED ACTIVE MATERIAL
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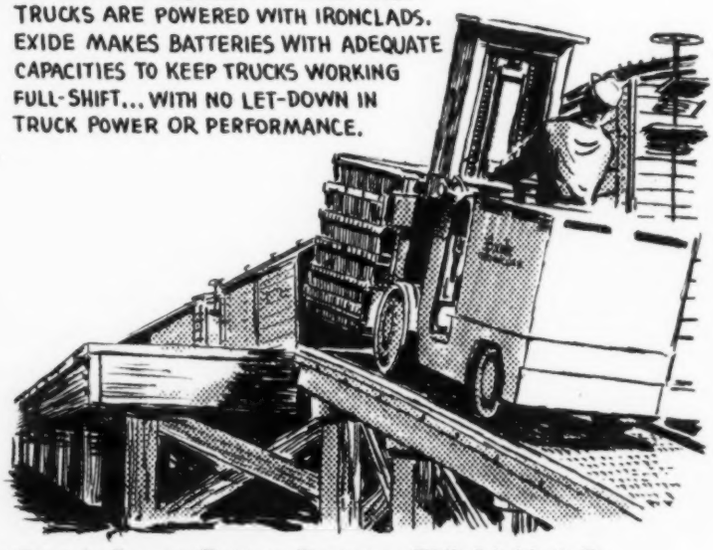
NO MOVING JOB IMPOSSIBLE!

STEEP RAMPS, LONG HAULS, HEAVY LOADS... NO JOB IS IMPOSSIBLE WHEN ELECTRIC TRUCKS ARE POWERED WITH IRONCLADS. EXIDE MAKES BATTERIES WITH ADEQUATE CAPACITIES TO KEEP TRUCKS WORKING FULL-SHIFT... WITH NO LET-DOWN IN TRUCK POWER OR PERFORMANCE.



LET EXIDE HELP SOLVE YOUR INDUSTRIAL TRUCK BATTERY PROBLEMS. ❶ CALL AN EXIDE SALES ENGINEER FOR FULL DETAILS. ❷ WRITE FOR FORM 1982, A MANUAL ON INSTALLING AND MAINTAINING MOTIVE POWER BATTERIES.

Exide INDUSTRIAL DIVISION, The Electric Storage Battery Company, Philadelphia 2, Pa.

Another Example of Better Bearing Engineering from **Bearings, Inc.**

NOW! PALLET WHEELS

for Sintering Plant Conveyors

Last and Last and Last!

Many steel plants are now depending on Bearings, Inc. to supply pallet wheel assemblies that give far greater service life than can be expected from other types of assemblies. And the reason? It's simple! Bearings, Inc. has designed a new and much improved labyrinth seal that retains the bearing lubricant and keeps out all dirt. The complete assembly is shown above. We supply seals for wheels in good condition or the complete assembly in single or double tread of flame hardened cast steel, complete with bearings.

BEARINGS, Inc., 3634 Euclid Ave., Cleveland 15, Ohio

Gentlemen:

I have a bearing problem I would like to discuss with you.

NAME_____

FIRM_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

OHIO: Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Lima • Youngstown • Zanesville

INDIANA: Ft. Wayne • Muncie • Terre Haute

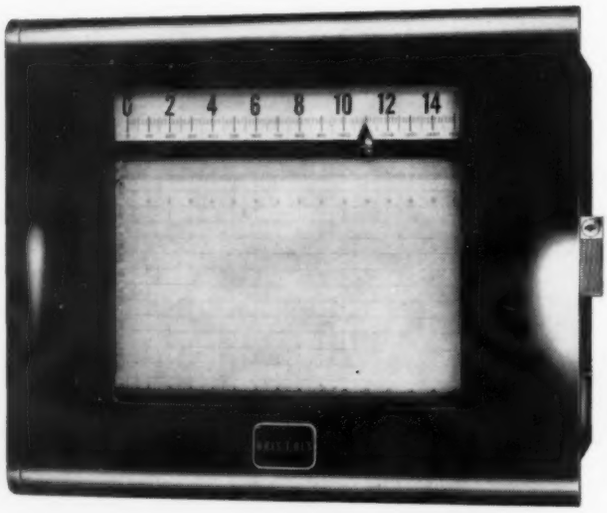
PENNSYLVANIA: Erie • Philadelphia • Pittsburgh • York

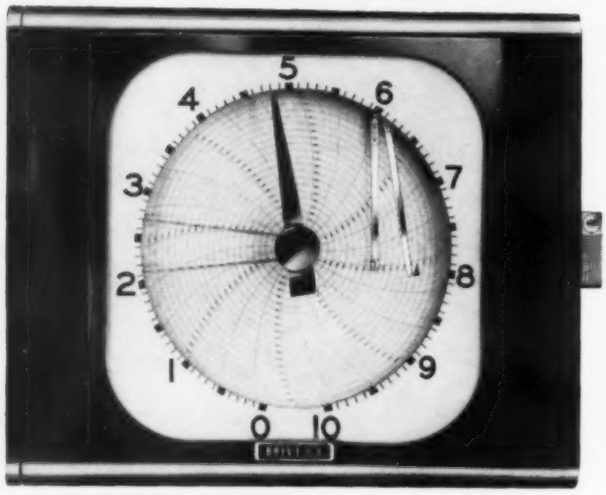
WEST VIRGINIA: Charleston • Huntington • Wheeling

NEW JERSEY: Camden

Subsidiary: Kentucky Ball and Roller Bearing Co. • Louisville, Ky.

WHAT'S NEWS AT BRISTOL . . .





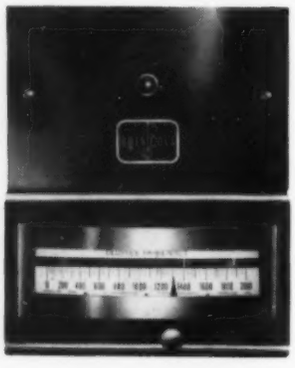
Three reasons temperature control is better with Bristol

FIRST TWO REASONS are Bristol's Electronic Dynamaster Potentiometers with strip chart or round chart. Here's why:

No-Batt Continuous Standardization in these instruments eliminates need for dry cells. Result: No interruption in operation for standardization, no batteries to replace.

Recorders for every requirement – single-pen, two-pen, and multiple-record (up to 24 points)

Electric and pneumatic controllers for every furnace and oven control mode, including *electric controllers* for on-off, proportional-input, 3-position, proportional, proportional plus automatic reset, and time-program control; and *pneumatic controllers* for on-off, proportional, proportional plus reset, and proportional plus reset plus derivative control.



THIRD REASON: Bristol's Free-Vane® Electronic Pyrometer Controller. No relay chatter with this controller! Bristol's thyratron-operated relay puts a stop to that. Minute changes in temperature – less than 0.003" on scale – close or open the relay with positive trigger action. Available in thermocouple and radiation pyrometer controllers in ranges up to 4000F. New high-torque, rugged millivoltmeter gives greater accuracy and a sensitivity of 15 ohms per millivolt. Separate plug-in control units, variety of control modes available.

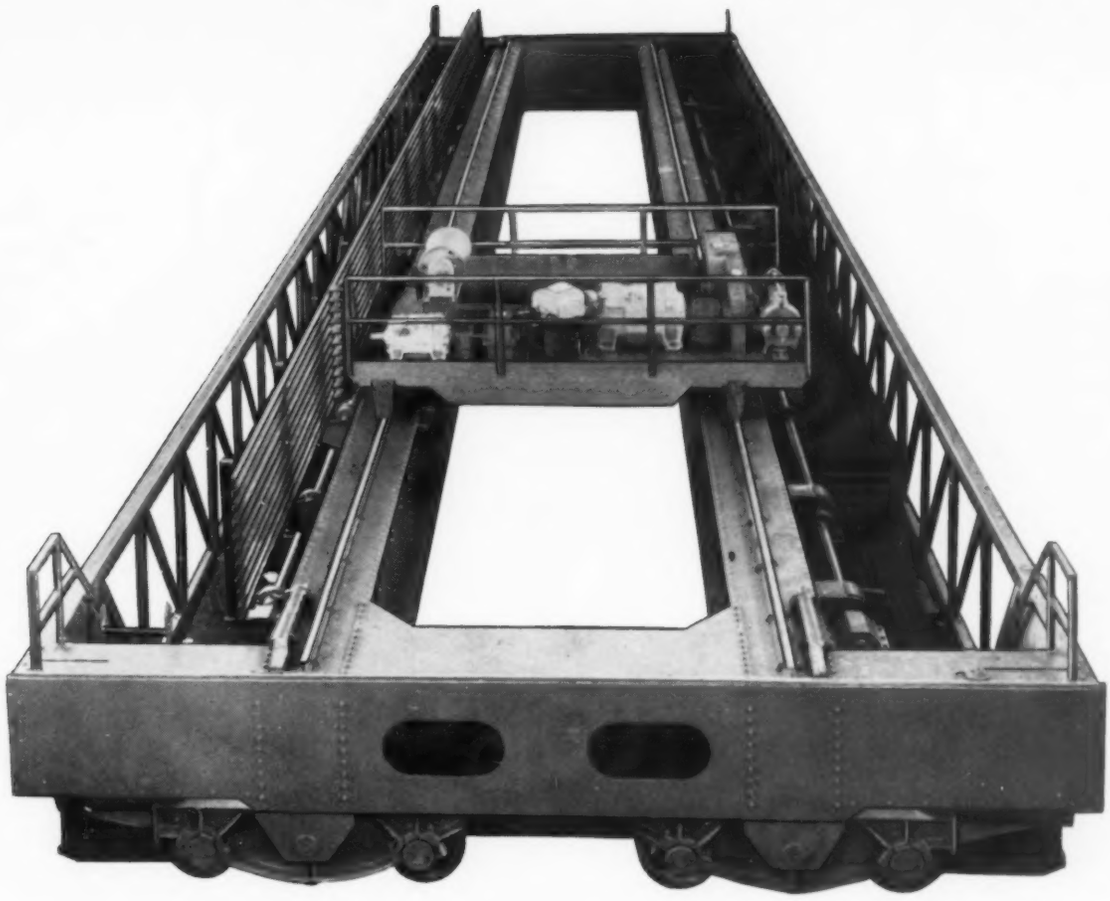
Get the whole story on these three rugged Bristol Furnace and Oven Controls. Write for free 48-page Bulletin P1260 today. It contains specifications, control diagrams and prices for every type of automatic heating control. The Bristol Company, 123 Bristol Road, Waterbury 20, Conn.

5.40

BRISTOL *POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION*

TRADE MARK BRISTOL'S REG. U.S. PAT. OFFICE

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



CRANES TO A.I.S.E. SPECIFICATIONS... by "Shaw-Box"

If your next cranes are to be built to A.I.S.E. specifications, you'll find your greatest value in "Shaw-Box" Cranes. Shaw-Box has standard designs and has already built many cranes up to and including 100-tons capacity to A.I.S.E. specifications. Typical of their interpretation of these specifications, is this 25-ton capacity, 100-foot span crane.

In "Shaw-Box" Cranes — whether built to an individual mill or to A.I.S.E. specifications — you get the added advantages that come from "Shaw-Box" engineering, fine workmanship, and precision manufacturing methods. These added advantages insure crane performance that make "Shaw-Box" Cranes — for the work they do — the least expensive cranes to buy and the most profitable to use.

BE SURE TO SEND ALL YOUR INQUIRIES FOR STEEL MILL CRANES AND SOAKING PIT CARRIAGES TO "SHAW-BOX."

"Shaw-Box" CRANES

MANNING, MAXWELL & MOORE, INC.

Muskegon, Michigan

Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, 'American' and 'American-Microsen' Industrial Instruments and Aircraft Products.

TRANTINYL

GUIDES THE STEEL INDUSTRY

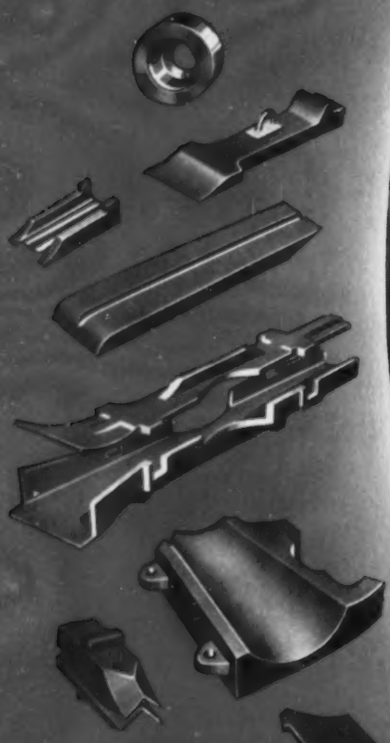
YOUNGSTOWN ALLOY CASTING CORPORATION

CELEBRATING

20 YEARS

OF SERVICE TO THE STEEL INDUSTRY

1935—1955



20-Year-Users find that "TRANTINYL" Alloy Steels have no equal—in tonnage rolled over one set of guides.

ROLLING MILLS:
bar, hoop, strip, shape mill guides; and rollers

SEAMLESS TUBE MILLS:
guide shoes, rolling mill plugs and rolls, piercer points, etc.

ELECTRIC WELD TUBE MILL.
forming rolls, planishing rolls, tool holders, etc.

STRAIGHTENING MACHINE GUIDES

HEAT RESISTING CASTINGS

Youngstown Alloy Casting Corporation

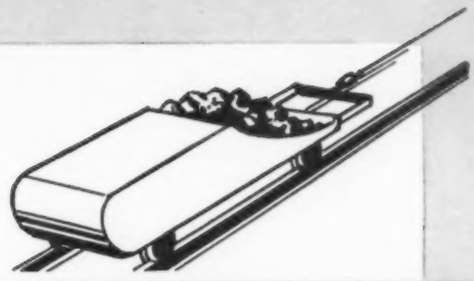
Youngstown, Ohio

If you have

BULK MATERIALS

that are.....

hoisted .....



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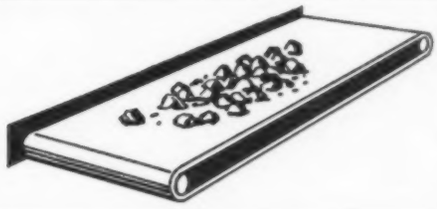

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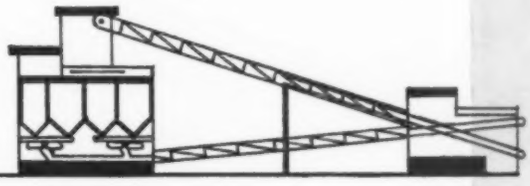

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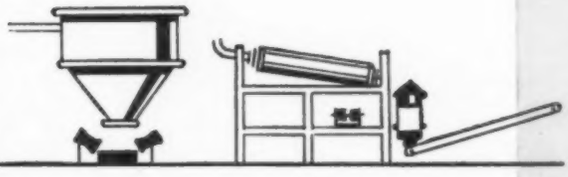

Roberts and Schaefer can help you with integrated planning, special design and construction . . . large or small.

Phone, wire or write for consultation. No obligation, of course.

ROBERTS and SCHAEFER COMPANY

Subsidiary of Thompson-Starrett Company, Inc.

ENGINEERS AND BUILDERS

130 North Wells Street, Chicago 6, Illinois

New York 19, N. Y.—254 West 54th Street

Pittsburgh 22, Pa.—1315 Oliver Building

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Hibbing, Minn.—P.O. Box 675

Pumping Progress Report

FOR HYDRAULIC ENGINEERS

An advertisement prepared by the Aldrich Pump Co., Member of Hydraulic Institute, U.S.A.

PROVIDING SMALL VOLUMES OF HYDRAULIC POWER at low, medium or high pressures is a problem frequently encountered by hydraulic engineers. Often, in the past, this was economically infeasible. Not so today, however.

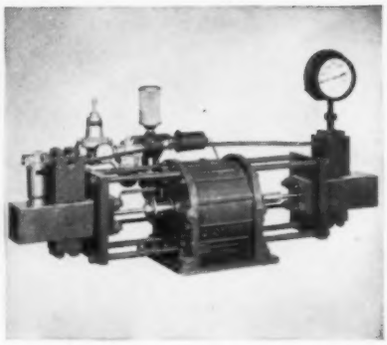
NORMAL PLANT COMPRESSED AIR is now utilized to operate small hydraulic pumps for production or laboratory use. These units are ideal for testing tubing, valves or pressure vessels and supplying power for die casting, plastic molding or belt presses.

ALDRICH AIR-DRIVEN HYDRAULIC PUMPS are completely self-contained; absolutely no auxiliary equipment is needed where air pressure is available. Each unit is fitted with an air filter, regulator, lubricator and hydraulic pressure gauge. Hydraulic plungers are available in sizes from 5/8-in. to 3-in. diameters.

HYDRAULIC PRESSURES are controlled by simple air regulator adjustment. Pressures as low as 103 psi are possible with a 3-in. diameter plunger utilizing 10 psig air pressure or as high as 37,000 psi with a $\frac{1}{2}$-in. plunger utilizing 100 psig air pressure. Between these two extremes falls most of the work for which small volumes of hydraulic power are specified. Special units are available for higher pressures.

INSTALLATION of air-operated hydraulic pumps is simple. The air cylinder is bolted to a foundation, and pump suction, pump discharge and air inlet lines are connected. The units occupy a minimum of space; the air cylinder base is only $12\frac{1}{2}$-in. x 14-in.

COMPLETE DETAILS of the ALDRICH Air-driven Hydraulic Pump are described and pictured in Data Sheet 36, which will be sent at your request. Address: The Aldrich Pump Company, 21 Pine Street, Allentown, Pa.



Aldrich Air-driven Hydraulic Pump

...for your tough pumping problems specify ALDRICH

One of the many tough pumping problems frequently faced by Aldrich engineers is that of supplying small volumes of hydraulic power at low, medium or high pressures.

In answer to this problem, Aldrich developed the completely self-contained Aldrich Air-driven Hydraulic Pump. Operating from a plant's normal compressed air supply, it can produce hydraulic pressure up to 23,700 psi, making it ideal for production or laboratory use.

Typical Applications for Aldrich Air-driven Hydraulic Pumps:

Testing: Tubes, Valves, Pressure vessels
Providing power for: Die casting, Plastic molding, Belt presses

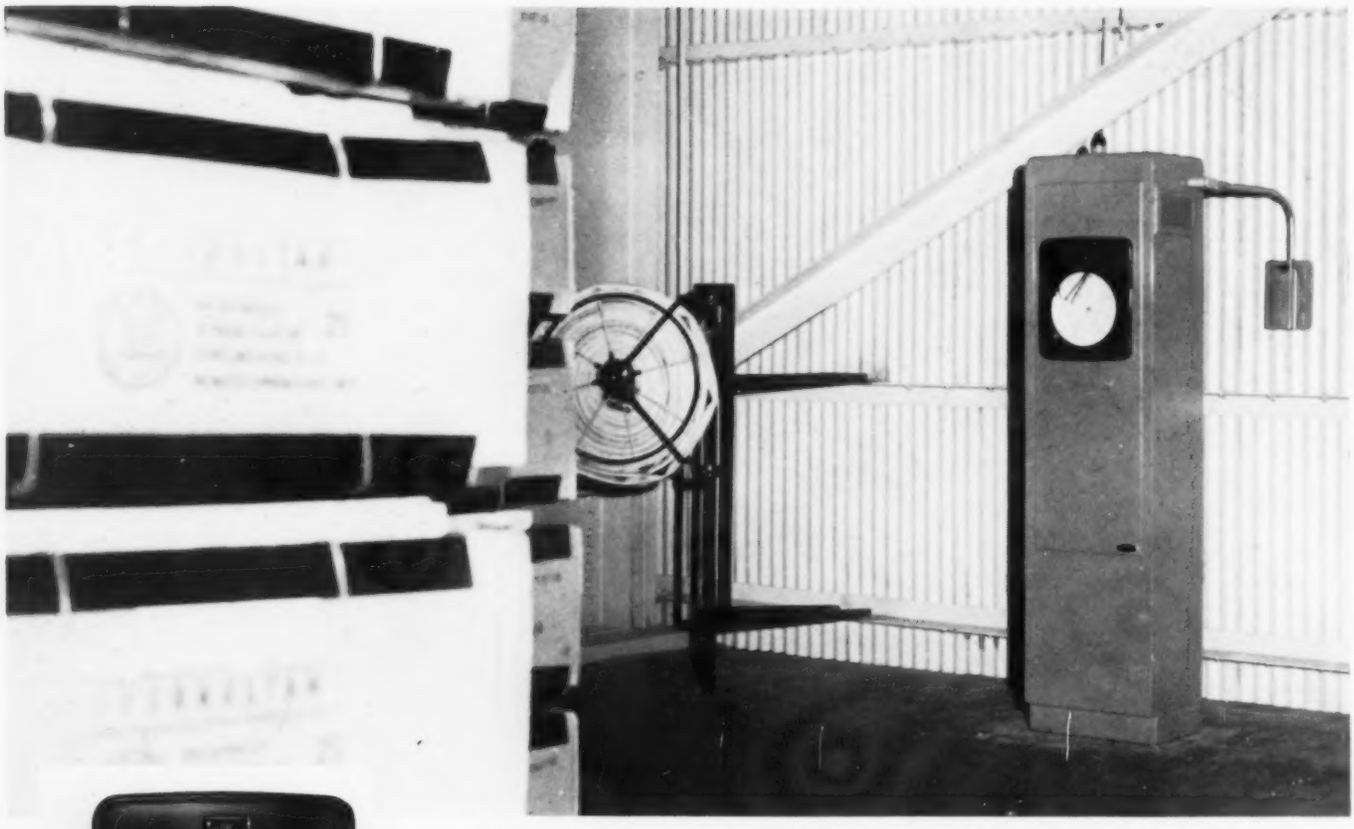
Write today for Data Sheet 36 describing the Air-driven Hydraulic Pump.

THE ALDRICH PUMP COMPANY

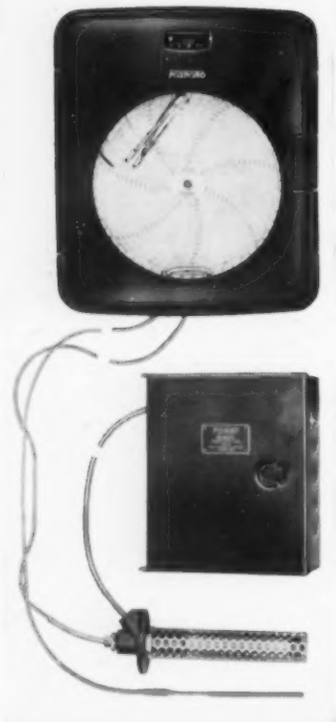
Originators of the Direct Flow Pump
21 PINE STREET
ALLENTOWN, PA.
Representatives in principal cities

MORGAN CONSTRUCTION COMPANY WORCESTER, MASS.
ROLLING MILLS • MORGOIL BEARINGS • WIRE MILLS • REGENERATIVE FURNACE CONTROL • EJECTORS • GAS PRODUCERS
H. H. Wood, Rep., Koppers Bldg., Pittsburgh, Pa. *English Rep.*, International Construction Co., 56 Kingsway, London W. C. 2, Eng.

Don't let steel sweat!



One of three "package unit" Foxboro Condensation Prevention Controllers which continuously guard storage areas in a large eastern steel plant.



. . . prevent moisture damage to stored steel with Foxboro Control

Steel in storage stays dry, resists rust and corrosion, when it's protected by a Foxboro Condensation Prevention Controller. This simple, inexpensive Controller automatically makes sure that air temperature in the storage area is always high enough above the dew-point to prevent costly condensation.

The Foxboro Condensation Prevention Controller employs the exclusive Dewcel* element to measure dew-point, and a dry bulb element to measure temperature. Control action automatically energizes signal devices, or operates valves in the building's heating system to hold air temperature safely above condensation point.

Operation of the Foxboro Condensation Prevention Controller is equally effective from 0° to 120°F. dew-point. It requires no water box or circulation of air — no air sample refrigeration under normal conditions. And there's practically no maintenance. Protect *your* sheets, rolls, and similar materials this modern, economical way. Write for Data Sheet 000-8 or call your nearest Foxboro Field Engineer.

* "Trademark"

← Controller (top) continuously measures and records dew-point. Dewcel "sensing" element (bottom) functions equally well in still or moving air. Instrument in center is Dewcel power unit.

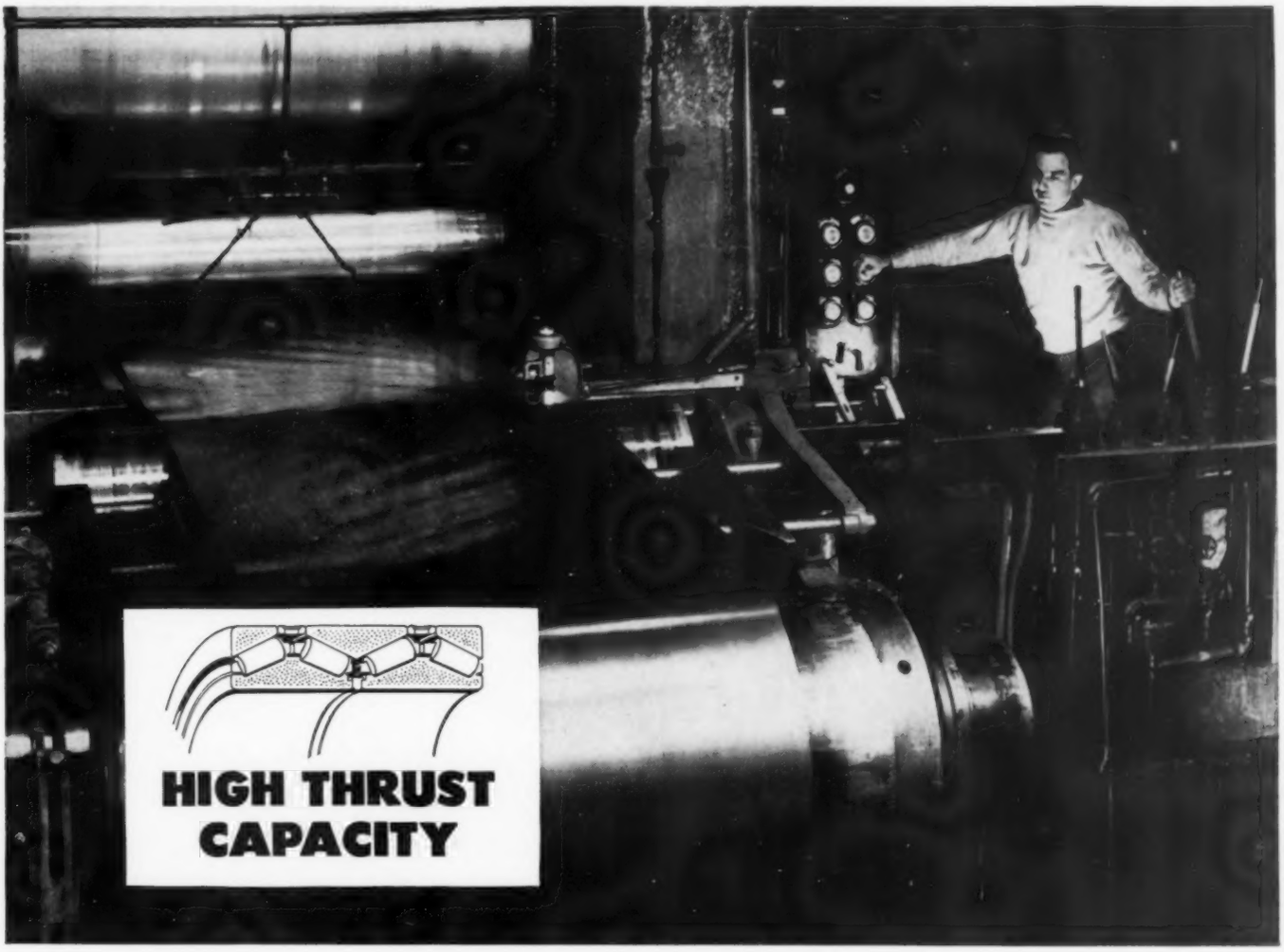
THE FOXBORO COMPANY, 5810 NEPONSET AVE., FOXBORO, MASS., U. S. A.

FOXBORO
REG. U. S. PAT. OFF.

CONDENSATION PREVENTION CONTROLLERS

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

IN THE STEEL INDUSTRY, TORRINGTON *Bearings are used extensively on work rolls, back-up rolls and for many auxiliary applications such as drives, pinion stands, coilers, etc.*



TORRINGTON Work Roll Bearings

are designed with steep angle construction to guarantee high thrust capacity under all operating conditions

High thrust capacity is just one of the many features of these bearings which have helped to establish many tonnage records.

TORRINGTON WORK ROLL BEARINGS are made of electric furnace alloy steels, carburized and heat treated to give maximum toughness, hardness, stability and uniformity.

One-piece, cast-bronze cages—with machined pads in each roller pocket—reduce wear, lengthen bearing life and improve tonnage performance.

Precision tolerances and finishes assure low eccentricity and cut friction to a minimum.

Specify TORRINGTON WORK ROLL BEARINGS in your rolling mill equipment. Many sizes—both two-row and four-row types—are available from stock for immediate shipment.

THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON TAPERED ROLLER **BEARINGS**

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

our youngster is ready for any job!

University of Hard Knocks

Know all ye men that

Ohio Forged Steel Rolls

have passed all tests for quality and performance and are doing an excellent job as work rolls in:

- Cold Reversing Mills
- Cold Reduction Tandem Mills
- Tin Plate Mills
- Aluminum and Non-Ferrous Mills

Prof. John D. Experience

Ohio Rolls

SHAPING METAL FOR ALL INDUSTRY

THE OHIO STEEL FOUNDRY CO.

LIMA, OHIO • Plants at Lima and Springfield, Ohio

Industry News...

DIRECTORS OF REPUBLIC STEEL CORP. APPROVE LARGEST EXPANSION PROGRAM IN FIRM'S HISTORY

▲ The largest expansion of steelmaking capacity ever undertaken by Republic Steel Corp. has been approved by directors of the corporation, C. M. White, president announced.

The expansion, which will represent a total investment of more than $130,000,000, will add 1,618,000 tons of steel ingot capacity to Republic's present capacity of 10,262,000 tons.

The new steel capacity will be added at Republic's basic steel plants in Cleveland, Warren and Youngstown in Ohio, Chicago, Ill., and Gadsden, Ala.

"While there will be some new open hearth and electric furnaces, most of the new ingot capacity will come from increasing the size of present production facilities," Mr. White said. "The cost will thereby be much less because we will be able to make use of existing structures and service equipment. In addition, the expansion will bring with it substantial operating savings as a result of improved efficiency brought about by the careful meshing of existing and new facilities.

"New finishing mills will be necessary to convert the additional ingot tonnage into products for the market. Our operating department is currently completing engineering for the mills. Included will probably be facilities for producing hot and cold rolled sheets and strip, electrical sheets and strip, bars and wire.

"The additional iron needed for the new steel facilities will result from the use of taconite pellets and the high-quality Labrador ore in our present 22 blast furnaces," "plus the advantage of high pressure blowing. This combination has already increased the efficiency of the blast furnaces and enabled us to produce substantially more iron with substantially the same facilities."

A program for producing flat rolled and galvanized sheets and strip in Gadsden was recently announced. At the Canton-Massillon plants a major expansion of stainless steel finishing capacity is almost completed. The present steel capacity of these plants is adequate to serve their markets for the time being at least.

TO INCREASE CAPACITY AT MONESSEN WORKS

▲ Announced by Pittsburgh Steel Co. is a 15-million dollar program aimed at reducing production costs and expanding basic ingot capacity.

The project, to be centered entirely at Pittsburgh Steel's Monessen, Pa., Works, will boost the company's basic ingot capacity by 15 per cent or 180,000 tons. Completion is scheduled at intervals starting May 1, 1956, and ending March 1, 1957.

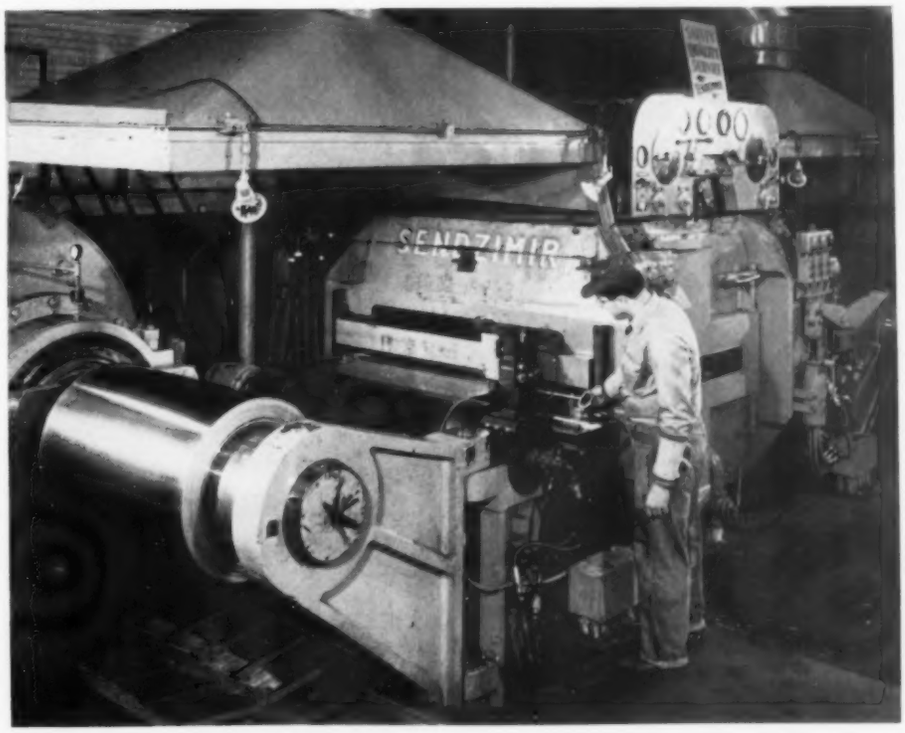
A battery of 19 of the latest type Koppers-Becker coke ovens will add 25 per cent or 144,000 tons a year to coke-making capacity. The 74 ovens now operated, and the 19 new ones will give a total annual capacity of 624,000 tons. Construction of the new ovens is to be completed by June, 1956. The new ovens will have stainless steel sealing members to guard against escape of air pollutants and odors.

Three of the four stoves of Blast Furnace No. 1 will be remodeled. Now three-pass stoves, they will be revised into two-pass stoves to improve their efficiency. Also to be installed on No. 1 furnace is a Kinney gas-washer. This will mean all three blast furnaces at Monessen will have two-stage systems for collection of air pollutants and odors.

A series of major modifications and improvements will be made to open hearths and their supporting equip-

NEW COLD REDUCING MILL OPERATING AT MASSILLON

Installed at Republic Steel Corp.'s stainless steel plant in Massillon, Ohio, this Sendzimir cold reducing mill is the major facility in a just-completed multi-million dollar program to expand stainless steel cold rolling and finishing capacity by approximately 25,000 tons annually. The mill can roll stainless steel up to 48 in. wide to a very light gage and provides a uniform, exceptionally smooth finish. The exit end of the mill is shown here.



Look Overhead . . . see "NORTHERN"

For heavy, continuous service in steel storage yards

The 40-ton, 75-foot span, heavy duty crane shown above is typical of many similar NORTHERN CRANE installations in steel mills, fabricating plants, and similar plants in heavy industry.

NORTHERN mill type cranes are designed and built to meet the most exacting requirements, providing for continuous service, maximum loads, and high impact allowances. Mill type motors and control equipment provide highest electrical performance.

NORTHERN CRANES are the result of over 55 years' experience in the design of overhead electric traveling cranes, heavy duty electric hoists and other materials handling equipment.

Let us send you our latest bulletins

NORTHERN MATERIALS HANDLING EQUIPMENT

NORTHERN ENGINEERING WORKS
210 CHENE ST., DETROIT 7, MICH.

ment. This program will be divided into three phases. The first involves three new charging machines, charging buggies, boxes and hot metal cranes. Second phase is new instruments, controls, motors, fans, electrical equipment, furnace doors and frame mechanisms. Final phase will include changes in the furnace structure, modifications of the checkers, furnace piping, front flushings, hot metal transfer and ingot buggies.

A welded wire fabric project will be undertaken to meet trade demands and increase the company's product diversification. Additional building space and materials handling equipment will be provided.

FIAT WILL CONSTRUCT VENEZUELAN STEEL MILL

▲ A Venezuelan iron and steel industry moved towards realization with the signing of a contract between the Venezuelan Government and the Fiat Motor Car Co. of Turin, Italy.

The Fiat Co., whose bid of $128,000,000 won out over the bids of groups from six other countries, including the United States, will immediately start construction of a steel mill with an eventual capacity of 421,000 tons yearly at the juncture of the Caroni and Orinoco Rivers.

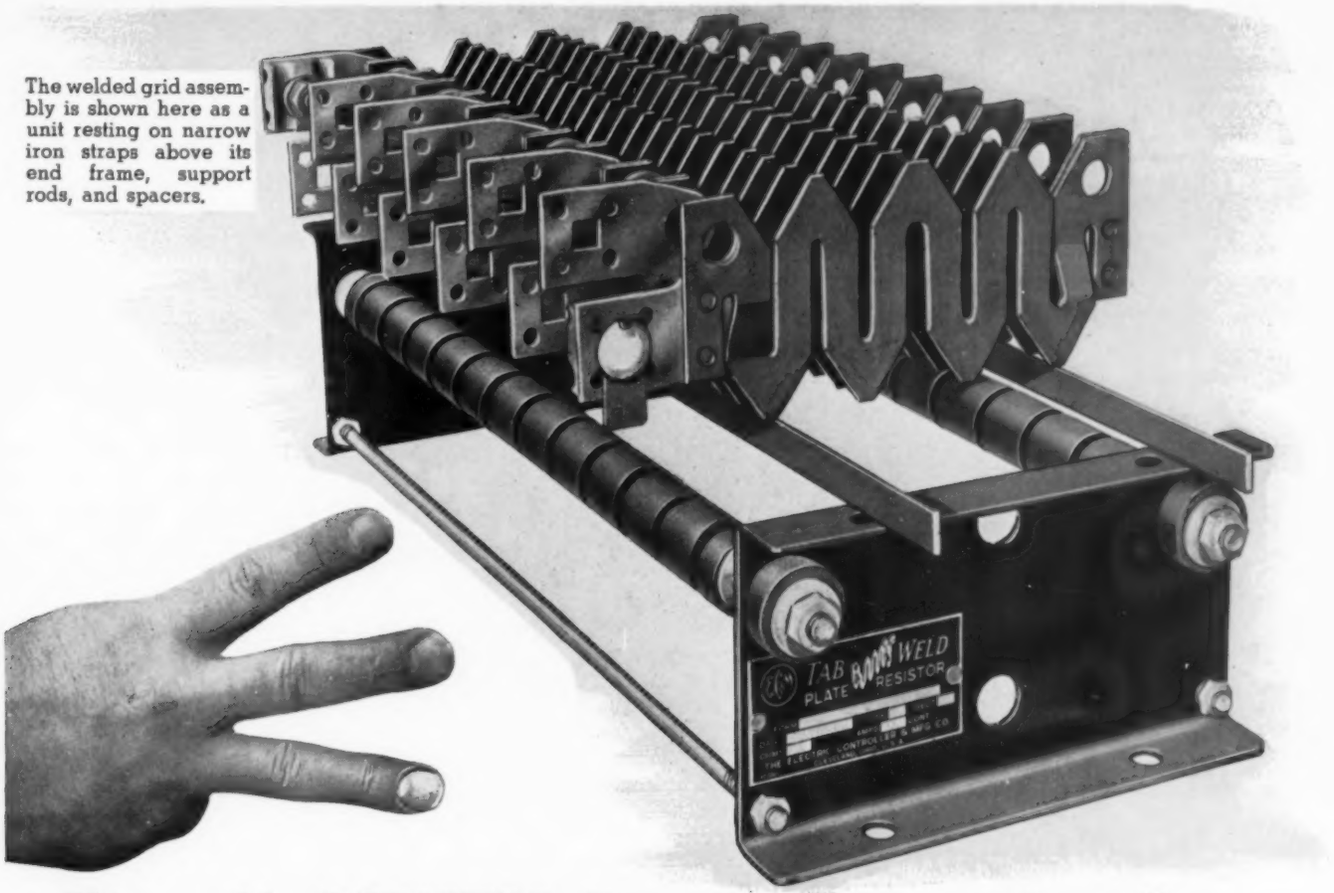
Within 200 miles of this point are some of the richest proved reserves of high grade iron ore in the world.

Venezuela's decision to establish her own industry is the outgrowth of a soaring increase in the use of steel over the past twelve years and a planned program of construction which will rocket the upward spiral in the years ahead.

The nation is now using 600,000 tons a year, or 14 times the 43,000 tons used in 1943. A 10-year National Railroad Program is under way and tremendous expansion is foreseen in public works and for private construction companies.

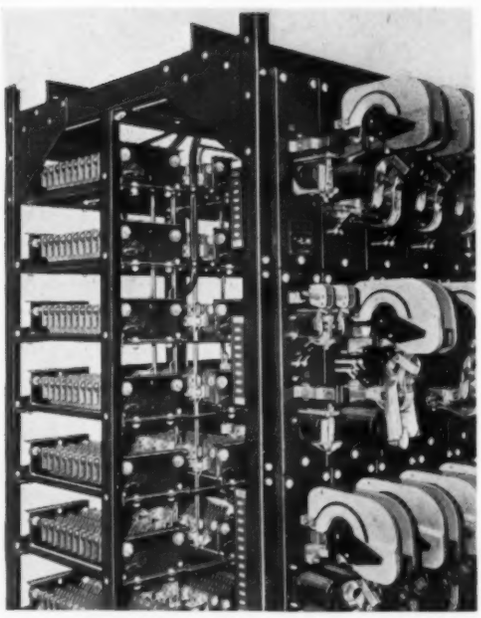
Venezuela's per capita use of iron and steel basic products is now over 220 lb a year, highest in Latin America. Mexico, for example, has a capacity consumption of only 79 lb.

Development of the project is planned in two stages. The first is based on an annual production of 300,000 tons, the second on a yearly production of 421,000 tons.



The welded grid assembly is shown here as a unit resting on narrow iron straps above its end frame, support rods, and spacers.

Steps Up RESISTOR Performance these 3 ways



TAB-WELD Resistors as part of Factory-assembled Control for recent Ore-Bridge Installation.

The *welded* grid-assembly of the EC&M TAB-WELD Plate Resistor reduces resistor maintenance costs and improves operation.

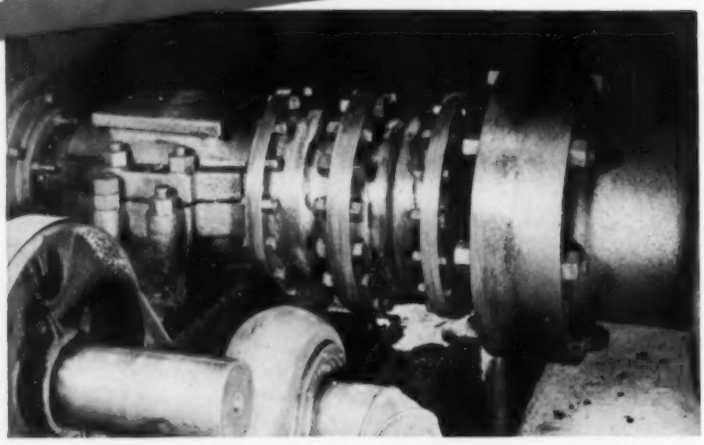
HERE'S HOW:

1. **Stabilizes** the Ohmic Value—A continuous path for current is maintained *independent* of the clamping-nuts.
2. **Stops burning** at grid-eyes and at tap-plates. Trouble is eliminated in these concealed areas due to *intimate* contact maintained by welding.
3. **Simplifies** Tap-Shifting—(a) when adjusting resistance to improve motor operation on an existing installation; (b) when necessary to replace a section, a standard mill section can be taken from the storeroom and used *without change* . . . External connections can be made to any one of the several tap-plates; only the external lead and terminal block need be moved to give the desired operation.

For low-cost, trouble-free operation, make up resistor layouts with EC&M Bulletin 942 TAB-WELD Plate Resistor Sections, made from corrosion-resistant steel.

THE ELECTRIC CONTROLLER & MFG. CO.
4498 LEE ROAD ★ CLEVELAND 28, OHIO

SPECIFYING A GEAR TYPE COUPLING IS NOT ENOUGH



Unretouched photo of WALDRON Heavy Duty Coupling between speed reducer and mill at Crucible Steel Co. of America, Syracuse, N. Y.

For An *Advanced* Gear Type Coupling, Leading Users Specify

WALDRON

As one of the oldest builders of couplings, WALDRON was first to introduce the modern refinements in the usual gear type design. Today's WALDRON Gear Type incorporates construction and operating advantages that insure greater dependability with less maintenance resulting in substantial savings over longer service life.

Such features as its forged steel construction, solid unit cover sleeve, longer lining up surface, oil film protection against wear, larger bore and less rotating weight are but a few of the reasons why it is the preferred gear type coupling in all industries.

Whatever your drive problem; there's a WALDRON Coupling to meet it. All steel for rugged work, all nylon where corrosion problem exists, combination of both for special applications.

WALDRON couplings are available in sizes up to 18" shaft diameter. We specialize in furnishing couplings for unusual applications and services. We would be pleased to send you our latest bulletin 55-I upon request.

JOHN WALDRON CORPORATION
New Brunswick, N. J.
Since 1827

Sales Representatives In Principal Cities

Most urgently needed products such as rails for the 2,640 mile-long network of national railroads, and basic construction materials such as reinforcing bars, wire, rods and nails, cast iron pipes for sewers and water mains, welded and seamless tubing and electrical conduit, will be produced during the first stage.

The latter stage will provide for increases in these items plus additional products such as hot and cold sheets, tinplate and galvanized sheets.

All raw materials needed for the plant will be provided from Venezuelan sources. In addition to the 65 per cent pure iron ore available at Cerro Bolivar, and in many other deposits in the Orinoco region, both coal and limestone are available and will be brought by ship from the Caribbean port of Guanta, in eastern Venezuela.

The coal, to be produced at the rate of 150,000 tons a year, will come from the mines at Naricual, near Guanta. These mines were closed in 1946, but are now reopened. Modern equipment is being installed. Reserves at Naricual are believed sufficient for 100 years.

Three Siemens-Martin furnaces of 175 tons capacity each will be used in the actual steel making. There will also be a reversible blooming mill of 40-42 in. roll diameter for the blooming of ingots, two rolling mills for light structural sections and rails, and three combined mills to roll reinforcement bars and wirerods. A foundry of 40,000 tons annual capacity will turn out cast iron pipe.

The Fiat bid includes construction of all subsidiary, maintenance and operational installations relating to the industry. These include special docks, unloading equipment, service railroads, offices, roads, warehouses, repair and maintenance shops and laboratories. Completion of the plant is scheduled for the latter part of 1957. Production is planned for early 1958.

NEW COKE OVEN BATTERY PRODUCING AT LORAIN

▲ Newly completed Battery H, at Lorain works of National Tube Division, U. S. Steel Corp. went into production September 7. Beginning of operations on the new 59-oven

There's an Alcoa® Aluminum Bus Conductor Engineered to Fit Every Bus Application

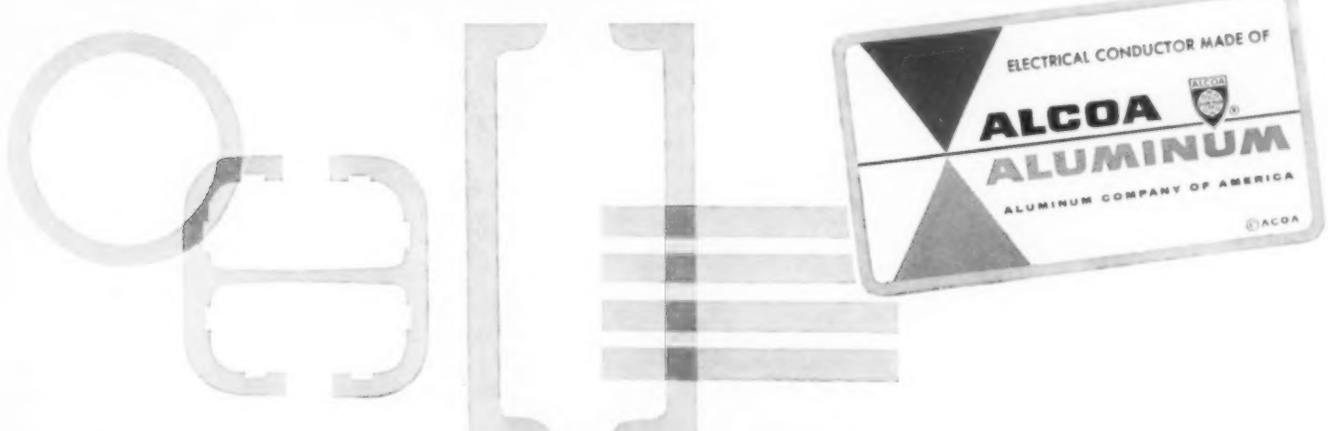
Alcoa Aluminum in a 480-volt switchgear unit. Main bus rated 1,600 amps and braced to withstand 75,000-amp short circuit.

Here is a recent switchgear application of Alcoa Aluminum Bus Conductors. Earlier Alcoa Aluminum Bus Conductor installations of this type are still in operation after thirty years of heavy-duty service in electrochemical plants, steel mills and public utilities.

Alcoa offers shapes, alloys and tempers designed to meet even the most specialized mechanical and electrical requirements, giving you significant savings in material and installation costs. Whatever your installation or bus design problem is, there's an Alcoa Aluminum Bus Conductor so right for the job it's almost custom fabricated.

Let us help you with your design to get the most out of the many types of Alcoa Aluminum Bus Conductors available. If you'd like to see what you can expect of this modern electrical metal, ask your local Alcoa sales office for a copy of *Service Records of Alcoa Aluminum Bus Conductor Installations*. Or write Aluminum Company of America, 2308-K Alcoa Building, Mellon Square, Pittsburgh 19, Pennsylvania.

Your Guide To Aluminum Value



ALWAYS USE ALCOA ALUMINUM ACCESSORIES WITH ALUMINUM CONDUCTORS

Washed iron ore from concentrating plant is stocked in 42-ft. high piles by Link-Belt 115-ft. radius revolving, self-propelled belt conveyor stacker with 570-ft. long track mounted trailer belt conveyor.

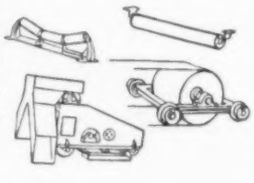
SURE ROAD TO LOWER HANDLING COSTS

... carry the load via Link-Belt belt conveyors

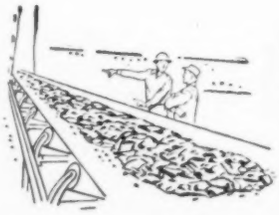
LINK-BELT offers you the "total engineering" so necessary for top efficiency

DESIGNED FOR OVERALL EFFICIENCY—Because of its unrivaled experience, Link-Belt can do a better job of gathering and analyzing all data. Proposals reflect this understanding of the most practical way to fit individual conveyors into your overall system requirements for best results.

BUILT FOR LONG-LIFE PERFORMANCE—Link-Belt manufactures all components and related feeders and conveyors. You are assured of the right equipment because of this breadth of line. And Link-Belt will supply the highest grade belts engineered to the specific job.



DELIVERS FULL RATED CAPACITY—Link-Belt follows through on every detail of the job, including electrical controls and even wiring and foundations. What's more, Link-Belt will furnish experienced erection superintendents, staffs and skilled crews at the customer's request.



ASSURES SATISFACTORY PERFORMANCE—When you rely on Link-Belt as a single source for your complete system, we accept responsibility for placing it in full operating readiness. We will also supervise modernization of existing systems. For all the facts call your nearby Link-Belt sales representative.

13,738-B

LINK-BELT

BELT CONVEYOR EQUIPMENT

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

battery followed by several weeks an announcement by Koppers Co., Inc., that work on still another new battery of by-product coke ovens will begin in the near future.

Battery H was built in a direct line with the 59-oven Wilputte Battery I which went into full-scale production for the first time in July. The two identical batteries will function as a single operating unit which will be joined eventually by the new Koppers battery, now already in the engineering phase of construction.

Self-sealing oven doors, double collecting mains and other auxiliary equipment of the new battery are expected to reduce the escape of fumes and gases into the air by as much as 90 per cent. Daily operations of the new unit will consume 1,083 tons of coal daily in the production of about 760 tons of coke.

CONTINENTAL TO VOTE ON BLAW-KNOX CO. BID

▲ The Board of Directors of Continental Foundry & Machine Co., meeting in Pittsburgh called a special meeting of stockholders for the purpose of considering and acting upon a proposal of Blaw-Knox Co. to purchase for cash the plant and equipment, inventories and certain other assets of Continental upon a basis which would provide approximately $51 per share for Continental stock in liquidation.

The stockholders at the special meeting to be held on or about October 31, 1955, will also be asked to consider and act upon a plan of complete liquidation of Continental. Stockholders of record at the close of business on September 27, 1955 will be entitled to vote at the special meeting.

CLARK TO ESTABLISH WEST COAST PLANT

▲ Clark Equipment Co. has announced plans to establish a West Coast plant before the end of the year.

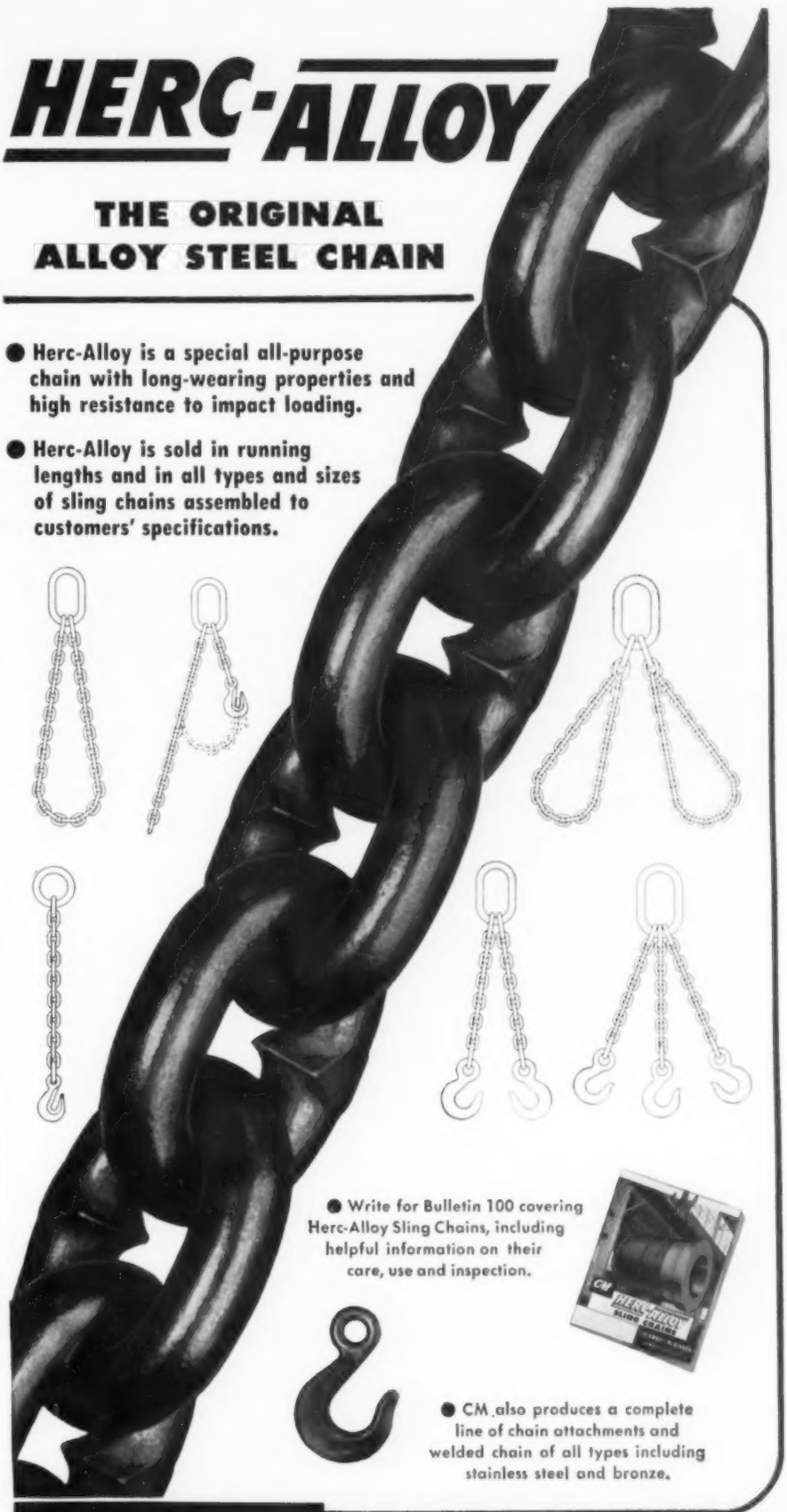
The new facility will be used as a parts depot at the outset, and later will be expanded as an assembly plant for fork lift trucks. It will be located in the San Francisco-Bay area and several properties are being investigated. Complete stocks of

HERC-ALLOY

THE ORIGINAL ALLOY STEEL CHAIN

● Herc-Alloy is a special all-purpose chain with long-wearing properties and high resistance to impact loading.

● Herc-Alloy is sold in running lengths and in all types and sizes of sling chains assembled to customers' specifications.



● Write for Bulletin 100 covering Herc-Alloy Sling Chains, including helpful information on their care, use and inspection.

● CM also produces a complete line of chain attachments and welded chain of all types including stainless steel and bronze.

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service parts for Clark and Clark-Ross industrial trucks and stradle carriers and for "Michigan" tractor shovels and excavator cranes will be warehoused.

TO CONVERT ACQUISITION INTO PIPE COATING PLANT

▲ Armco Steel Corp. will convert the recently purchased Middletown facilities of Warren Steel Corp. into a modern pipe coating plant.

About $360,000 will be spent to move the company's present pipe coating operation to the new plant and to install necessary equipment and facilities.

New machinery for coating Armco welded-steel pipe with coal tar enamel will include abrasive cleaning equipment and a wrapping machine which coats the outside of the pipe and wraps it with a protective material.

The new unit is expected to be in operation by the middle of December. To be operated as part of the pipe manufacturing department of Armco's Fabricating Plant, it will be known as fabricating plant No. 2.

Armco purchased the plant and office buildings comprising the new plant as well as some equipment from Warren Steel last June for approximately $300,000.

GE WILL CONSTRUCT NEW RECTIFIER PLANT

▲ A General Electric Co. plant costing in excess of $5,000,000 will be built at Lynchburg, Va., as the new home for the company's rectifier department, now located at Lynn, Mass., and at Limerick, Maine.

Grading of the plant site will begin in November, and actual construction of the plant will start in March, 1956. Initial production is scheduled for January, 1957.

ANNOUNCES ADDITIONS AT EAGLE MOUNTAIN MINE

▲ A multi-million dollar addition to Kaiser Steel Corp.'s iron ore mining facilities at Eagle Mountain, Calif., has been announced. Supplementing a beneficiation plant that went into operation last year, additional facilities will be built to upgrade further the already high quality iron ore being mined there.

The shipping grade of the ore, now running about 55 per cent iron content will be upped to over 60 per cent with the new facility.

MORGAN ESTABLISHES NEW YORK OFFICE

▲ Establishment of a New York district office has been announced by the Morgan Engineering Co. Manager of the new district office, to be located at 30 Church St., New York City, is J. Campbell Dolan, formerly administrative assistant to the president since 1952.

WHEELING SETS MONTHLY PRODUCTION RECORDS

▲ Wheeling Steel Corp. announced monthly production records set in August.

Output of pig iron reached the record figure of 155,413 net tons during the month, exceeding the May, 1955 record of 144,669 tons.

No. 5 blast furnace at Steubenville South Works produced 28,955 net

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In Blast Furnaces—Because of its practically iron-free composition, Super #3000 shows exceptional resistance to carbon deposition and alkali attack. This plus its volume stability and great abrasion resistance make it the strongest refractory mortar for blast furnace work.

In Butt Weld Pipe Furnaces—Resetting fire brick arches and wash coating with Super #3000 has provided continuous service for many months, whereas other mortars failed in 5 to 6 weeks.

In Coke Ovens—Repairing floors while still hot with Super #3000 has saved one plant $10,000 in maintenance in a few months.

There are a great many more reports of Super #3000 success—where other refractory mortars have failed quickly and utterly—in furnace walls, arches and floors, soaking pits, sinter towers, ladle linings, etc. Users call it the "Wonder Cement." Try it—you'll agree.

REFRACTORY & INSULATION CORP.

R&D

REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS

136 WALL STREET • NEW YORK 5, NEW YORK

tons of pig iron, exceeding the June, 1954 mark of 28,516 tons.

The Converting department at Steubenville South made 42,638 net tons of steel. The previous record for this department was 38,226 tons in May, 1955.

The Blooming Mill at Steubenville South rolled 40,126 net tons more than the May, 1955 record.

LaBelle Works turned out a record 13,914 kegs of hardened nails. The previous record figure was 12,507 kegs produced in June, 1955.

TO BUILD COKE OVENS AT MONESSEN WORKS

▲ A contract for the design and construction of a 19-oven coke battery with auxiliary equipment, to be erected at Pittsburgh Steel Co.'s plant at Monessen, Pa., has been awarded to Koppers Co., Inc.

The new coke oven battery will increase the coal carbonizing capacity of the Monessen plant 25 per cent to 2500 net tons per day. The 19 ovens will be of the Koppers-Becker underjet type.

In addition to the ovens, the contract calls for the construction of a primary cooler, a final cooler, a coke pusher and other coke handling equipment, and an electrostatic precipitator. This auxiliary equipment has been designed in keeping with Pittsburgh Steel's over-all program at Monessen.

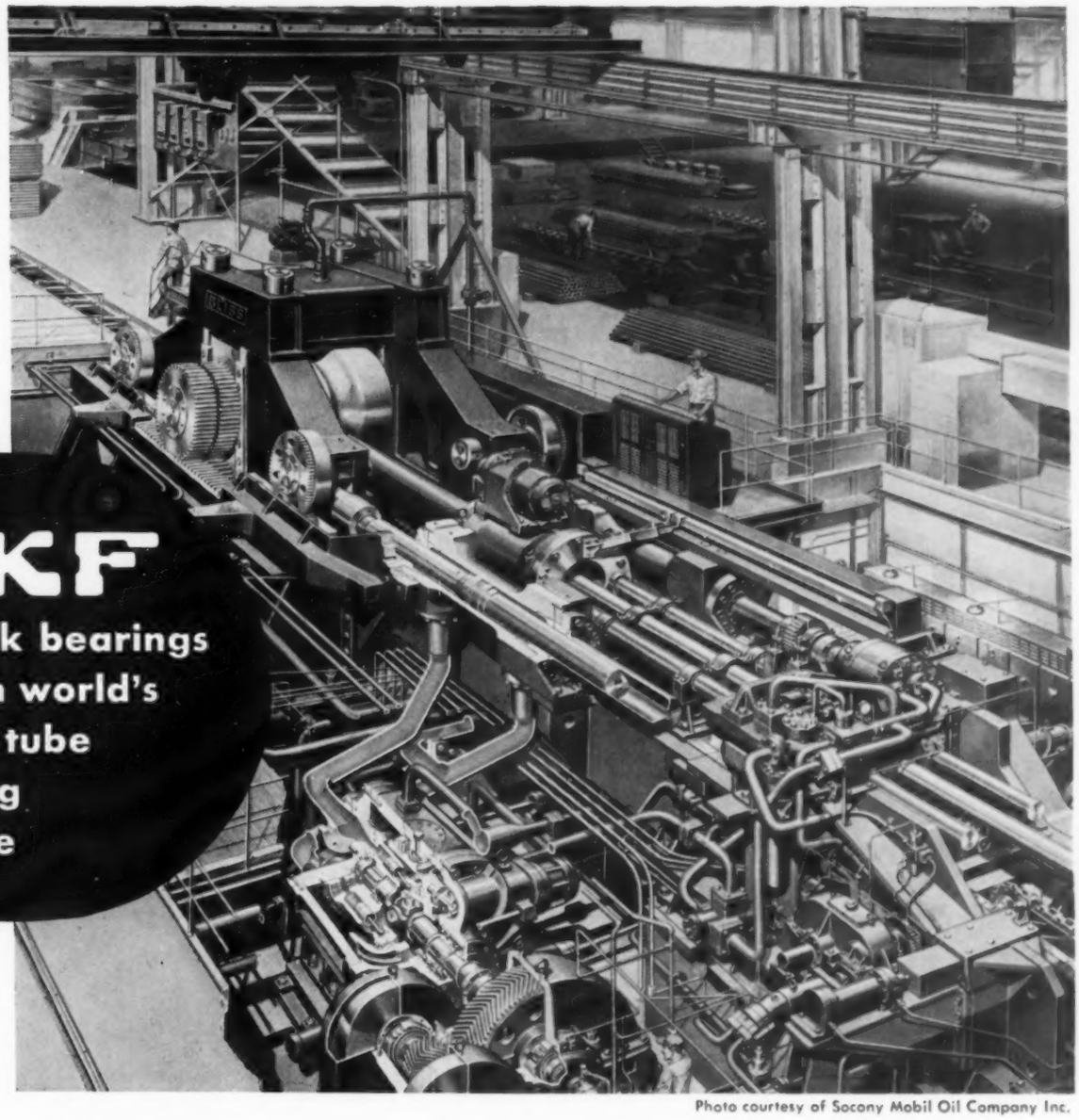
Construction of the new battery, along with its auxiliary equipment, will be completed by June 1956.

NEW CAMPBELL BATTERY PLACED IN OPERATION

▲ A new 76-oven coke battery was placed into operation at the Campbell Works of the Youngstown Sheet & Tube Co. in Youngstown, September 30. It has a daily capacity of 1250 tons of coke, or about 450,000 tons a year.

The new ovens, which feature underjet firing, have 730 cu ft of capacity. They are 43 ft 2⅜ in. long, 13 ft 2⅜ in. high and average 18 in. in width with a 3 in. taper. The battery is more than 350 ft long.

The new ovens are on the site of the old number one battery. Ground was broken in September of last year.



SKF

roll neck bearings used on world's largest tube reducing machine

Photo courtesy of Socony Mobil Oil Company Inc.

SKF sphericals absorb tremendous punishment, provide greater bearing capacity

This 102 foot long giant tube reducing machine, designed and operated by Tube Reducing Corporation, Wallington, N. J., for the U. S. Navy Bureau of Aeronautics, and built by E. W. Bliss Company, Canton, Ohio, puts a 3½ million pound squeeze on precision tubing of outer diameter sizes ranging from 9 to 17 inches for military and commercial cold finished tubular products.

The mammoth bearings for 50" diameter rolls on the machine are SKF Spherical Roller Bearings. They are the largest spherical roller bearings of this type ever made, with a rated capacity of 3,200,000 lbs. Each bearing weighs 5150 lbs.; individual rollers weigh 39½ lbs.

The Tube Reducing Corporation first employed SKF Spherical Roller Bearings in 1937 for a 2¼" tube reducing machine having 13" diameter rolls. Today, *all* tube reducers in this plant are SKF-equipped... from the smallest to the 102 foot giant.

Like the men at Tube Reducing Corporation, organizations that pioneer advancements in their fields are accustomed to find that SKF matches their vision with advanced bearing design that helps them make a working reality of their most ambitious and forward-looking plans.

Make SKF Engineering cooperation a *plus* factor in the successful realization of your company's planning and development program. 7831

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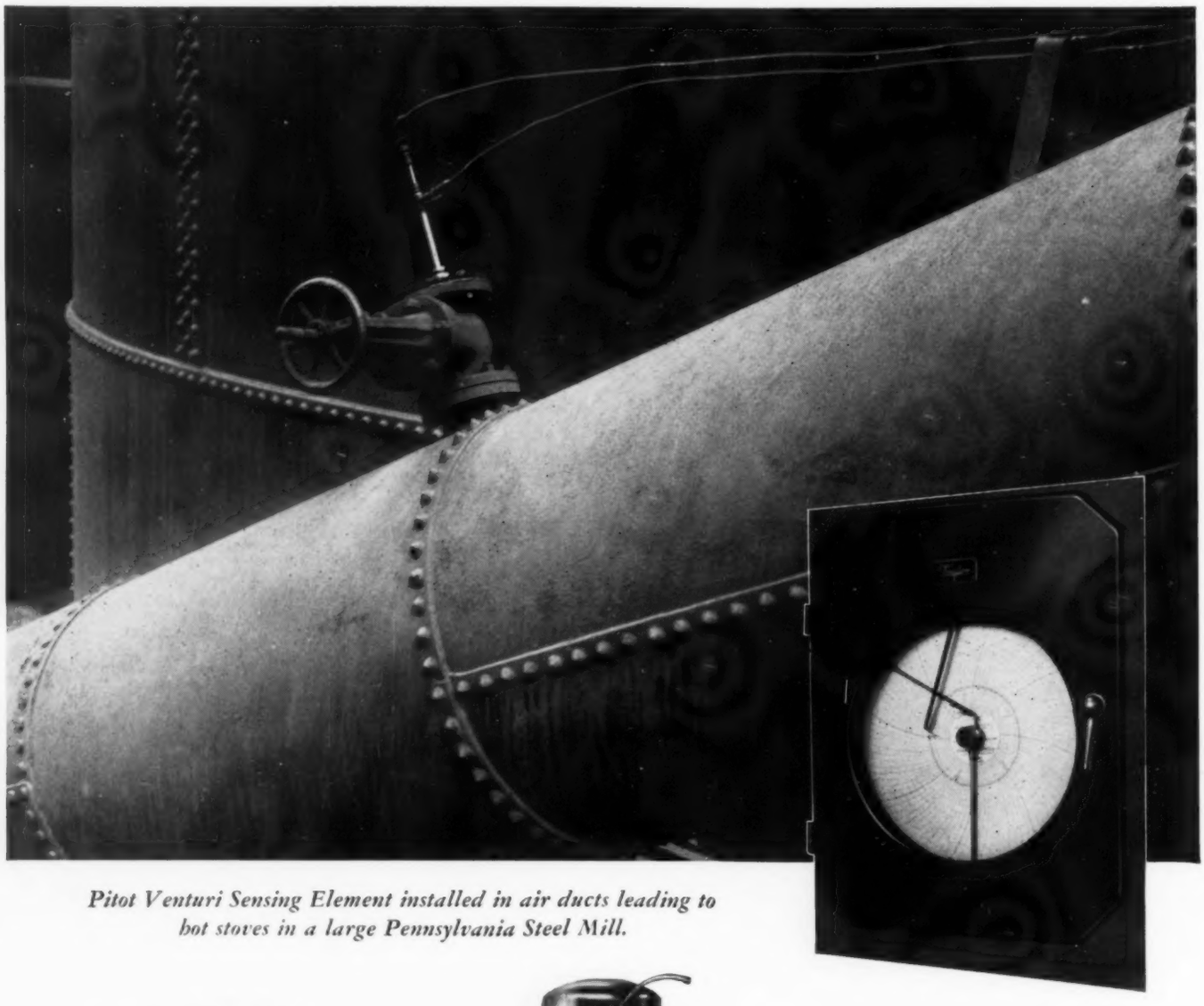
BALL AND ROLLER BEARINGS

How Taylor Instrumentation



Pitot Venturi Sensing Element installed in air ducts leading to hot stoves in a large Pennsylvania Steel Mill.

Taylor FULSCOPE* Recording Controller

For close accurate control of temperature, pressure, flow or liquid level. Quickly adapted to operating requirements by virtue of interchangeable unit-construction. With one or two complete control systems. Instantly accessible for all adjustments. Simplicity of operation, long life, low maintenance.

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Simple, rugged, reliable—install it and forget it! Requires no auxiliary air supply. Double-seated valves available in sizes up to 2″; single-seated composition disc types up to 1″. Many standard temperature ranges between 10° and 340°F., and semi-standard ranges within limits of 135° and 610°F.

Bi-Metallic Dial Thermometer

3″ or 5″ diameter case. Rugged stems, 4″, 6″, 9″, and 12″. Separable wells, ¾″ and 1″; 2″ extension neck for 6″ and 12″ stems. Range limits, minus 40° to plus 750°F. Ranges up to 400°F. damped against vibration. All-stainless steel construction. Good accuracy at low cost.

gives you BETTER PROCESSING CONTROL

IN the metals industry today there are many aspects of production and processing, including the manufacture of by-products in integrated plants, where automatic control is becoming increasingly necessary. Efficiency, quality of product, and economy of operation are dependent more and more on accurate measurement and control.

Taylor Instrument Companies, one of the oldest in its field, is known throughout industry as the source of rugged, dependable and accurate control instrumentation. Its engineering staffs are highly trained. Many Taylor engineers are regarded as national authorities in their fields. They are widely experienced in dealing with application problems in diverse industries . . . and they are always at the service of Taylor customers.

Shown here are some of the Taylor instruments that have proved their value in use on metals production and processing applications. Your Taylor Field Engineer will be glad to show you how an individual instrument or a complete control system can help you improve efficiency and cut costs. Why not give him a call today, or write Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

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Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

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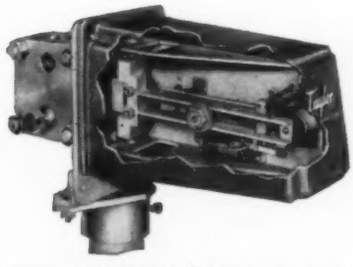
Taylor Recording Pressure Gauge
Available for static pressure, absolute pressure or differential pressure, or combinations. 12″ chart with spring or electric chart drive for any required period of rotation. Die cast aluminum case can be face or flush mounted. Easily converted to a FULSCOPE controller.



Taylor TRANSAIRE* D-P Transmitter
A rugged, dependable and accurate instrument designed to measure flow, liquid level or specific gravity. Simplified piping; side, top or bottom bracket mounting; no seal pots; self draining or venting; simple range change. 10-1 range ability in each of 2 forms; 20-200″ water; 80-800″ water.

Taylor Recording Thermometer
Gives you a continuous chart record—your best check on the efficiency of both operators and equipment. One, two or three pen models. Actuation by mercury, vapor, gas or organic liquid. In mercury systems Taylor ACCURATUS* Tubing compensates for variations in temperature along the tubing.

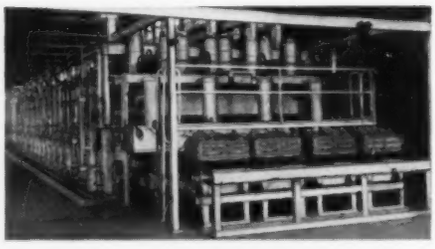
How to Select the Most Economical Insulating Firebrick

The advantages of lightweight insulating firebrick over ordinary "heavyweight" firebrick are generally known to furnace operators and furnace builders. But many buyers have wondered just what advantages there might be in one brand of insulating firebrick as against another. The answer to this question could very well mean savings in fuel costs, increased furnace output, longer life . . . or all three.

One furnace builder ran tests on their small electric kilns where heat input could be measured with great accuracy. Here's what they found: B&W IFB required 25% less heat than any other brand of insulating firebrick they tried.

The reason? B&W IFB are lighter in weight than any other insulating firebrick — they contain more tiny, insulating air cells. Heavier, denser insulating firebrick linings waste fuel two ways: They soak up and store more heat which is lost when the furnace is cooled; and they conduct more heat through the walls.

How about long life? One of the

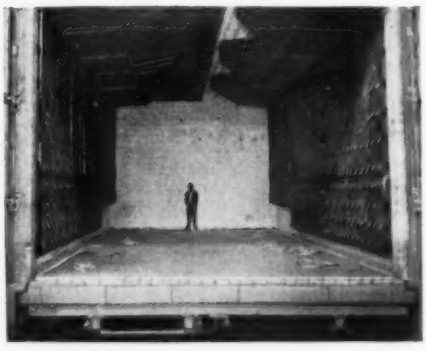


toughest tests of firebrick is in the lining of a carbon monoxide furnace. Some brands last only a few weeks, then disintegrate, due to iron oxide impurities in the brick which react with the gas.

But B&W Insulating Firebrick contain little iron oxide, and they're processed at high temperatures so that any traces of iron oxide form stable compounds. So instead of deteriorating they stay on the job year after year —in many cases over 10 years.

Another factor, important to many furnace operators, is accurate temperature control. Here again B&W IFB have an advantage over other insulating firebrick. First, because B&W IFB are lighter in weight they store and conduct less heat—and they respond more quickly to changes in heat input.

A typical example is the giant stress-relieving furnace shown below—sixty feet by twenty-two feet by seventeen feet high. The B&W lining plays a vital part in holding the desired temperature within 5 degrees accuracy!



Next time you buy or specify insulating firebrick, remember that the lightest weight brick of all—B&W—has the highest insulation value, the longest life and the greatest furnace heat controllability.

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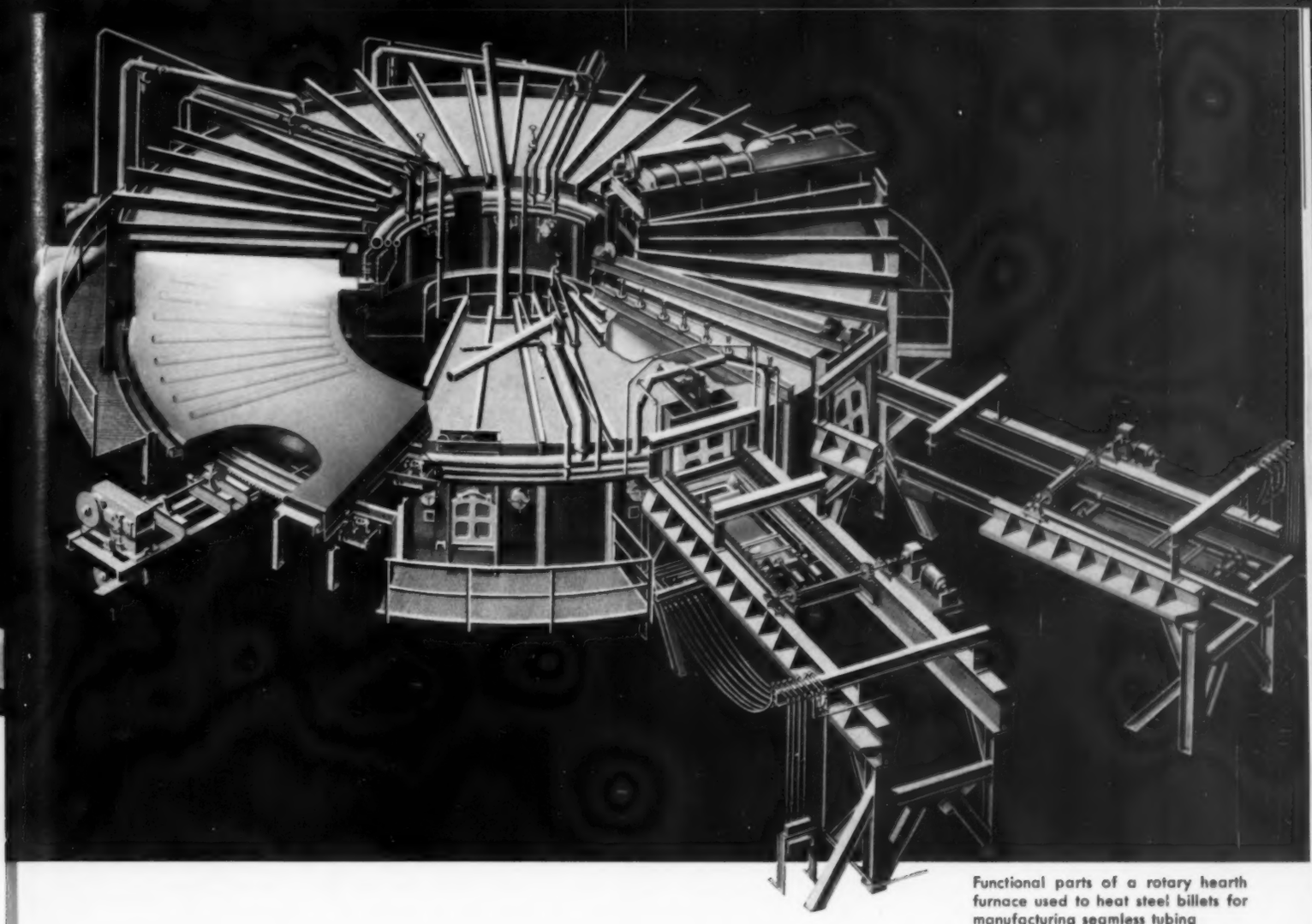

Functional parts of a rotary hearth furnace used to heat steel billets for manufacturing seamless tubing

Increase Productivity, Save Space, And Cut Fuel Costs With Salem-Brosius Rotary Hearth Furnaces

Most large rotary hearth furnaces in the world have been designed and built by Salem-Brosius or its licensees. Salem-Brosius developed the large rotary hearth furnace and continuously has improved its design and construction.

Salem-Brosius rotary hearth furnaces are in use today for production heating and heat treating carbon and alloy steel bars, slabs, round and square billets, shell stock and forging stock; and similar products in non-ferrous metals such as copper and brass.

The rotary type furnace saves floor space. Fuel efficiencies and economies are unequalled by any other type of industrial furnace. Heating is rapid and uniform. Charging and discharging is mechanical; and automaticity of control drastically cuts labor costs. A Salem-Brosius rotary hearth assures the minimum of maintenance and repair costs. These benefits spell higher furnace output, less downtime, lower production cost—and greater profit to you, the user.

The rotary hearth is but one of the many types of Salem-Brosius furnaces—furnaces of superior design and construction—furnaces that help improve your product and turn it out at a lower cost. If your plant modernization plans call for heating or heat treating furnaces of any kind, call on Salem-Brosius.

Other Salem-Brosius products include forging manipulators, furnace charging and discharging equipment, hot materials handling equipment, large gas main valves, blast furnace clay guns, and a long list of special machinery and auxiliary furnace equipment. A Salem-Brosius engineer will be glad to help you with problems involving any of this equipment, or any special equipment that must be tailored to your needs. Write to us.

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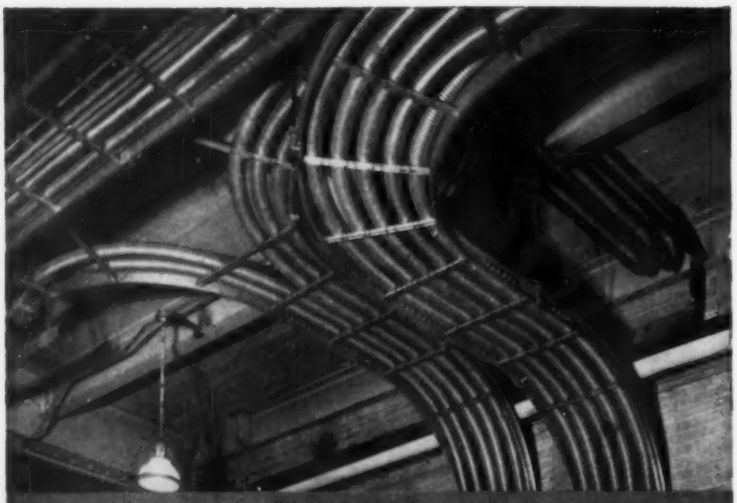
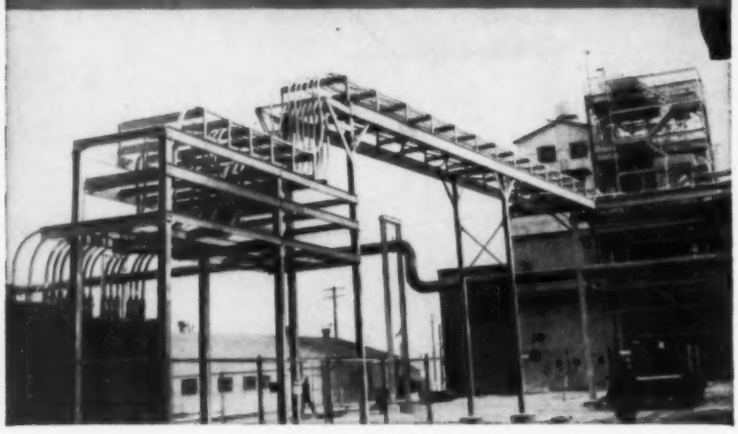


INDOORS

OUTDOORS



rubber-insulated LOXARMOR CABLES save space, reduce cost

Considerable interest is growing throughout industry in Loxarmor (interlocked armor) Cables for use in locations where the maximum protection of a rigid conduit is not required. Okonite's interlocking Loxarmor covering makes the cable flexible and easy to train (minimum bending radius 8 times cable O.D.) and at the same time provides mechanical sturdiness. Installation costs are lower than for rigid conduit systems, and Loxarmor's accessibility makes it easier and cheaper to reroute or add circuits. Its compactness provides important space-saving features where runs must be installed around existing plant equipment. Loxarmor coverings can be supplied in galvanized steel, aluminum, bronze or copper.

Okonite rubber-insulated Loxarmor Cables are insulated with Okonex, a butyl-base compound applied by Okonite's famous strip-insulating process. Vulcanized in a metal mold, the insulation forms a solid dielectric wall which has better moisture resistance and electrical properties than laminated varnished cambric insulations. The superiority of Okonex is indicated by its higher insulation resistance, lower dielectric loss, lower power factor and lower specific inductive capacity.

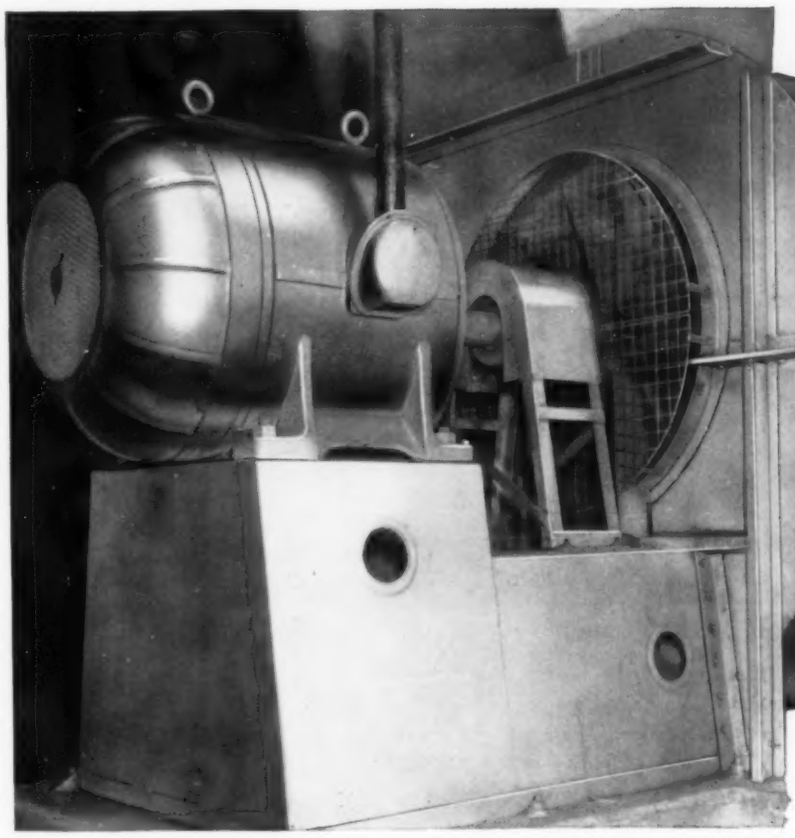
Okonex-insulated Loxarmor Cables are suitable for operation up to 15,000-volts and at conductor temperatures up to 85C. For complete information on Okonite Loxarmor Cables, including detailed splicing and terminating drawings and instructions, write for Bulletin EI-1090. The Okonite Company, Passaic, N. J.

Available with either copper or aluminum conductors

OKONITE SINCE 1878 *insulated cables*

2976

RIGHT FOR THE SEVERE MILL MOTOR COOLING JOB!



"Buffalo"

MILL MOTOR FAN

Mill motor cooling calls for fans able to take heat, pressure and continuous service — and we build these fans accordingly. The heavy steel plate housing, the strong, rigid wheel with massive hub, heavy-gauge back plate, flange and die-formed blades — are part of the "Q" Factor* that goes into these "Buffalo" Fans.

For the best answer to your mill motor cooling problem, call on your nearby "Buffalo" representative. A Graduate Engineer, trained in our factory and in the field, he's ready and competent to cooperate with your own engineers or contractors in any air handling application.

- Built to stand heat and develop high pressures
- Cannot be overloaded
- Heavy construction — to **stay** on the job
- Desirable performance characteristics
- High in efficiency — backward curved blades and inlet guide vanes

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

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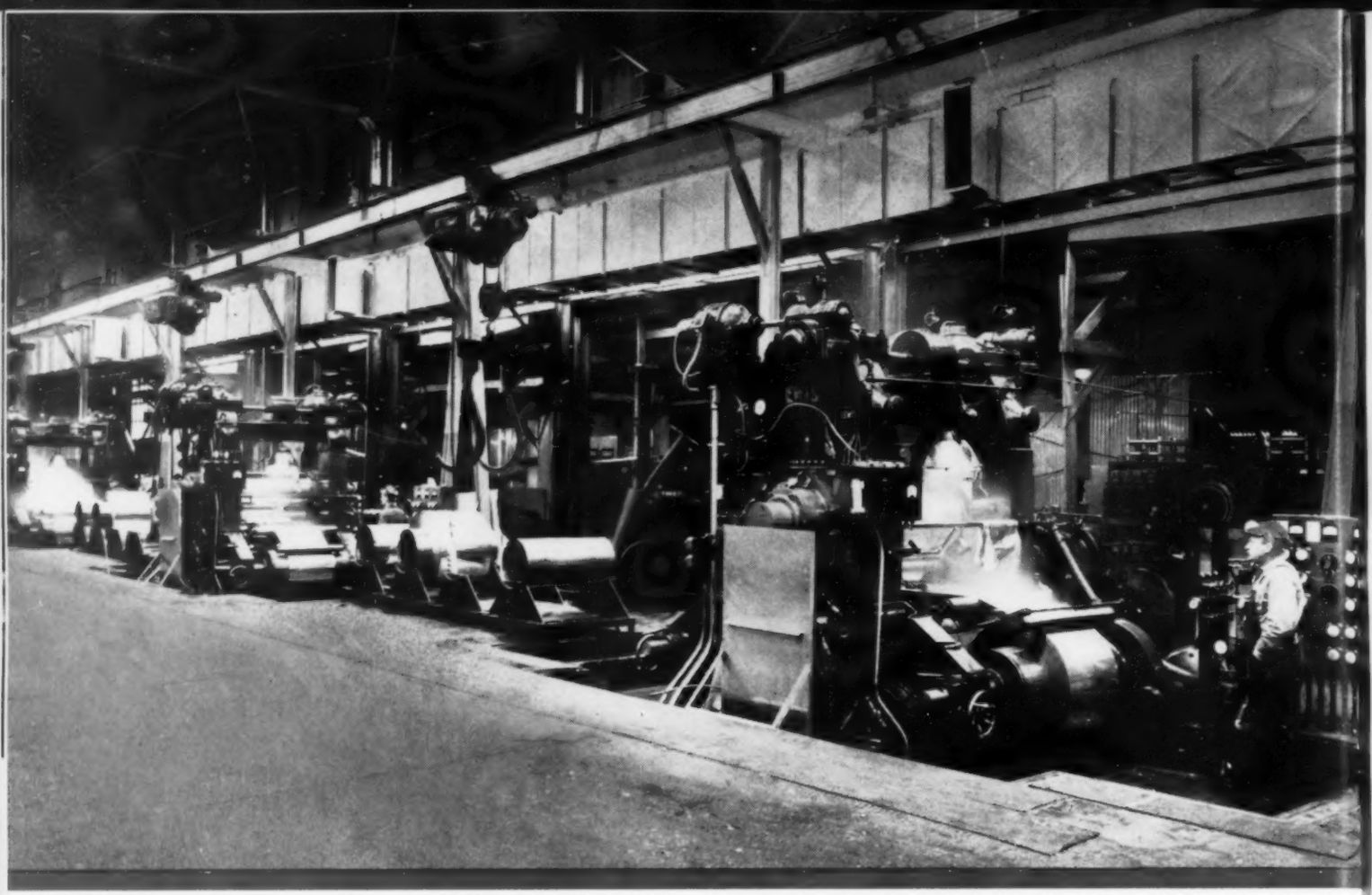


battery of 9" and 21" x 44" Lewis four-high Foil Mills

. . . high production mills roll foil at speeds up to 4000 fpm

Whether you want to start with an ingot from a hot mill or start with coils, you can get a full range of Lewis equipment, designed and built to meet your specific requirements. Over one hundred modern Lewis Foil Mills, for example, are now successfully operating in plants of the country's top ranking aluminum foil producers.

Built in various sizes and widths to meet individual customer requirements, these Lewis Foil Mills include the latest design in bearings, electric tension control, thermal control and handling equipment. They usually start with .030" or .026" sheet and can reduce down to .00025" . . . at speeds ranging from 1000 to 4000 feet per minute.

So call us in the next time you're in the market for a mill to roll aluminum. Our engineers, who have had extensive experience in the development of high speed mills, will study your requirements with you. This experience plus modern manufacturing facilities will assure you of getting the type of equipment best suited to your specific needs.

LEWIS four-high FOIL MILL

BLAW-KNOX COMPANY • LEWIS MACHINERY DIVISION
PITTSBURGH 30, PA.

BLAW-KNOX

LEWIS PRODUCTS: Two-High Mills • Three-High Mills • Four-High Mills • Strip Mills • Bar, Billet and Structural Mills • Plate Mills • Rod Mills • Coilers • Tables • Shears • Pinion Stands • Gear Drives • Roll Lathes

Personnel News...

William D. Spaulding has been elected vice president — operations of Great Lakes Steel Corp. Before his advancement to this position, Mr. Spaulding was manager of the Steel Works of Weirton Steel Co. He began his association with National Steel Corp. in 1924 in the Coke Plant of Weirton Steel Co. **R. W. Grace** has been appointed manager of the Steel Works of Weirton Steel Co. to succeed Mr. Spaulding, **G. K. Gordon** has been promoted to assistant manager of the Steel Works and **James J. Veselich** to superintendent of the bessemer department. Mr. Grace entered the employ of Weirton Steel in 1925 in the blooming mill department. He was appointed assistant superintendent of the blooming mill in 1943, advanced to superintendent in 1952 and in August 1954 was promoted to assistant manager of the Steel Works, which position he held at the time of the new appointment. Mr. Gordon started with Weirton Steel in 1937 in the bessemer department, and became superintendent of the department in 1948, holding the position continuously from that time until the present appointment to his new position. Mr. Veselich began his employment with Weirton in 1937 in the bessemer department.

Ralph C. Moffitt was named assistant vice president and director of purchases of United States Steel Corp. With this appointment, Mr. Moffitt retains his present responsibilities and assumes those of **R. L. Van Cleve,** assistant vice president — purchases, who is retiring after 41 years with U. S. Steel. **William W. Crawford** has been appointed assistant director of purchases of United States Steel Corp. In his new position, Mr. Crawford will supervise those purchasing activities relating to construction materials and services and electrical and mechanical equipment. At the same time, **Everett G. Barrett** was appointed purchasing agent, electrical and mechanical equipment. Mr. Barrett will retain his present responsibility of purchasing for foreign operations.

K. S. Kuka has been promoted to the position of assistant chief engineer (electrical), in the works engineering division of the Tata Iron and Steel Co. Ltd., Jamshedpur, India. Mr. Kuka is a member of the AISE and the author of a number of papers printed in the Iron and Steel Engineer, several of which have received honorable mentions in the Kelly award paper selections.

Porter R. Wray has been appointed assistant chief metallurgical engineer, U. S. Steel Corp. At the same time **A. W. MacLaren** was named metallurgical engineer — alloy steels and **J. R. Hamilton** assistant metallurgical engineer — structural, plate and high strength steels.

Walter Cochrane has been appointed Foreman — Maintenance at Wheeling Steel Corp. Mr. Cochrane started his career with Wheeling Steel in 1939 as a machinist's apprentice at the Benwood Works. In 1946 he was transferred to the Martins Ferry factory as a machinist where he served until his promotion.

Hubert B. Smith has been appointed director of product engineering at the Claymont, Del., plant of the Colorado Fuel and Iron Corp. Mr. Smith was formerly vice president in charge of research with the Great Lakes Steel Corp. He had been associated with Great Lakes Steel since 1936. Prior to joining Great Lakes, Mr. Smith was chief metallurgist with the Otis Steel Co.

Robert P. Bremner has been appointed manager of mining operations for the Youngstown Sheet and Tube Co. Mr. Bremner joined Youngstown's raw materials department early in 1948 and was appointed mining engineer in July of the same year. In 1951 he was advanced to assistant to the vice president in charge of operations.

Paul E. Barley has been appointed superintendent of maintenance at the Ambridge Plant of A. M. Byers Co. Mr. Barley was previously employed by the A. M. Byers Co. for 19 years until 1952, when he accepted the position of superintendent of construction and maintenance for the Green River Steel Corp. at the construction of the corporation's new plant at Owensboro, Ky.

W. P. Holloway was appointed assistant superintendent of the Bessemer and 44 in. blooming mill, South

WILLIAM D. SPAULDING

RALPH C. MOFFITT

K. S. KUKA

PORTER R. WRAY

E. K. (GENE) MILLER

ELWOOD B. NELSON

RALPH R. SWAIN

DR. CLARENCE E. LARSON

Division of Wheeling Steel Corp. He has been with Wheeling since 1946, starting as a metallurgical assistant at the Benwood Works. In 1953, Mr. Holloway was made general foreman in the bessemer department, which position he retained until his recent promotion.

E. K. (Gene) Miller retired after 44 years in the steel industry, 26 years of which were spent as an official of Jones & Laughlin Steel Corp. Mr. Miller's formal retirement, according to J&L's policy of compulsory retirement at age 65, is announced simultaneously with his decision to open an office as a consultant. Mr. Miller's new office will be in the Grant Building, Pittsburgh. Mr. Miller served J&L in many capacities, principal of these being vice president — production and, prior to that, assistant vice president—operations. Mr. Miller's career in the steel industry began when he joined the Carnegie Steel Co. in 1911. Later he became superintendent of blast furnaces, of the Tennessee Coal, Iron and Railroad Co. (a U. S. Steel affiliate), and in 1929 joined Jones & Laughlin as assistant general superintendent of the Aliquippa Works where he became general superintendent in 1947. He rose to the position of assistant to the vice president — operations of the Jones & Laughlin Steel Corp. that same year and became assistant vice president — operations in 1949.

Elwood B. Nelson has been named general manager of the coal mining division of U. S. Steel Corp.

Ralph R. Swain has been named manager of the Bailey Meter Co.'s Iron & Steel Division. He will coordinate the company's sales activities in this field.

Dr. Clarence E. Larson has been appointed vice president in charge of research for National Carbon Co., Division of Union Carbide and Carbon Corp. Dr. Larson was formerly director of the Oak Ridge National Laboratory, operated by Union Carbide for the Atomic Energy Commission.

L. J. Cross has been promoted from assistant purchasing agent to purchasing agent of Wheeling Steel Corp.

Edwin C. McDonald, former superintendent, combustion department, Corrigan-McKinney Works, Republic Steel Corp., has been appointed assistant chief combustion engineer, Republic Steel Corp., effective October 1.

E. H. Hollenback has been appointed chief metallurgist of the Johnstown, Pa., plant of Bethlehem Steel Co. He succeeds **R. Earl Penrod,** who retired August 31. Mr. Penrod served Bethlehem and its predecessors in Johnstown for 53 years, the entire time in metallurgy.

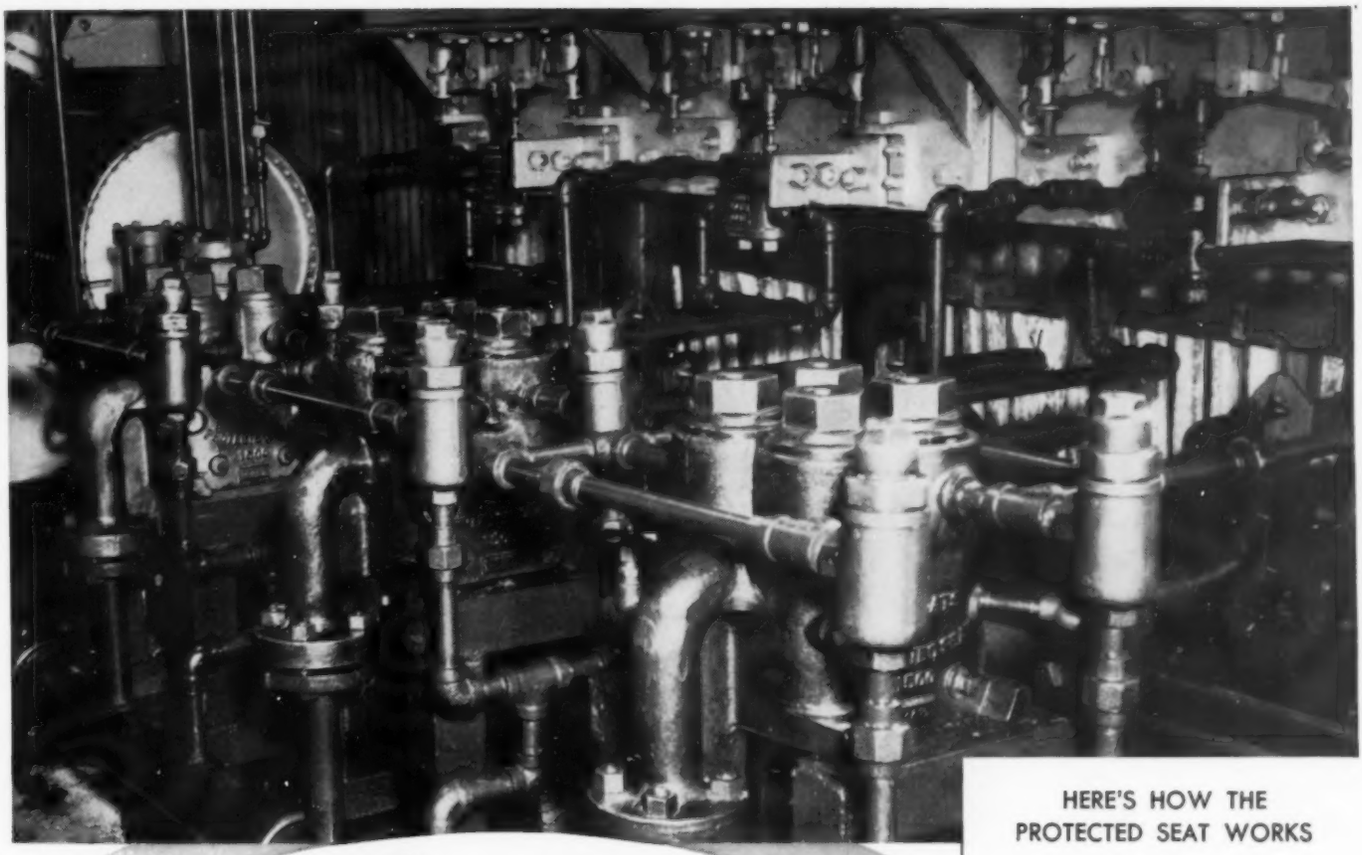
Paul Kreps has been appointed assistant superintendent of the transportation department of Republic Steel Corp.'s Warren, Ohio, plant. Mr. Kreps succeeds **Harold R. Dueber,** who recently was named superintendent of the department.

Don L. Hinmon has been named general manager of the new Industrial Insulations Division of Johns-

DON L. HINMON

Manville Corp. Other division general managers named are **Francis J. Wakem,** Packings and Friction Materials Division, and **Robert F. Orth,** Pipe Division.

A. J. Bradshaw, former vice president of W. Vance Middough & Associates and **E. S. Harrar,** formerly electrical project engineer with Arthur G. McKee & Co., and recently consultant with W. Vance Middough & Associates, announce the formation of Harrar-Bradshaw & Sons, consulting electrical engineers, specializing in



for fast, smooth, accurate control

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RECORDS OF 6 TO 18 MONTHS' MAINTENANCE-FREE SERVICE ARE COMMON

It will pay you to get the facts about HOMESTEAD Protected-Seat HYDRAULIC OPERATING VALVES—the valves that give you quick, finger-tip control for moving or positioning any single-acting or double-acting hydraulic piston. The exclusive Homestead Protected-Seat reduces fluid velocity during the closing operation to practically zero. Thus seat erosion and resultant leakage, the most frequent cause of shut-downs and lost production time, is eliminated. Records of 6 to 18 months continuous service without maintenance are common.

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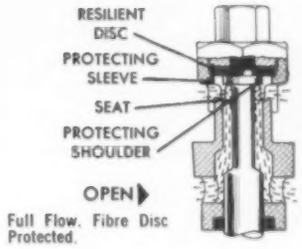

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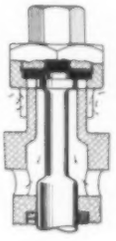
Full Flow. Fibre Disc Protected.



CLOSING OR ◀ OPENING
Flow practically stopped by close fitting sleeve and stem shoulder, before seat and disc make contact. This prevents "wire drawing." Trapped water cushions closing, dampens hydraulic shock.

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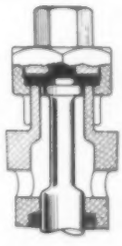
Protected resilient disc against metal seat assures drop-tight seal, long life, accurate control, and low maintenance.



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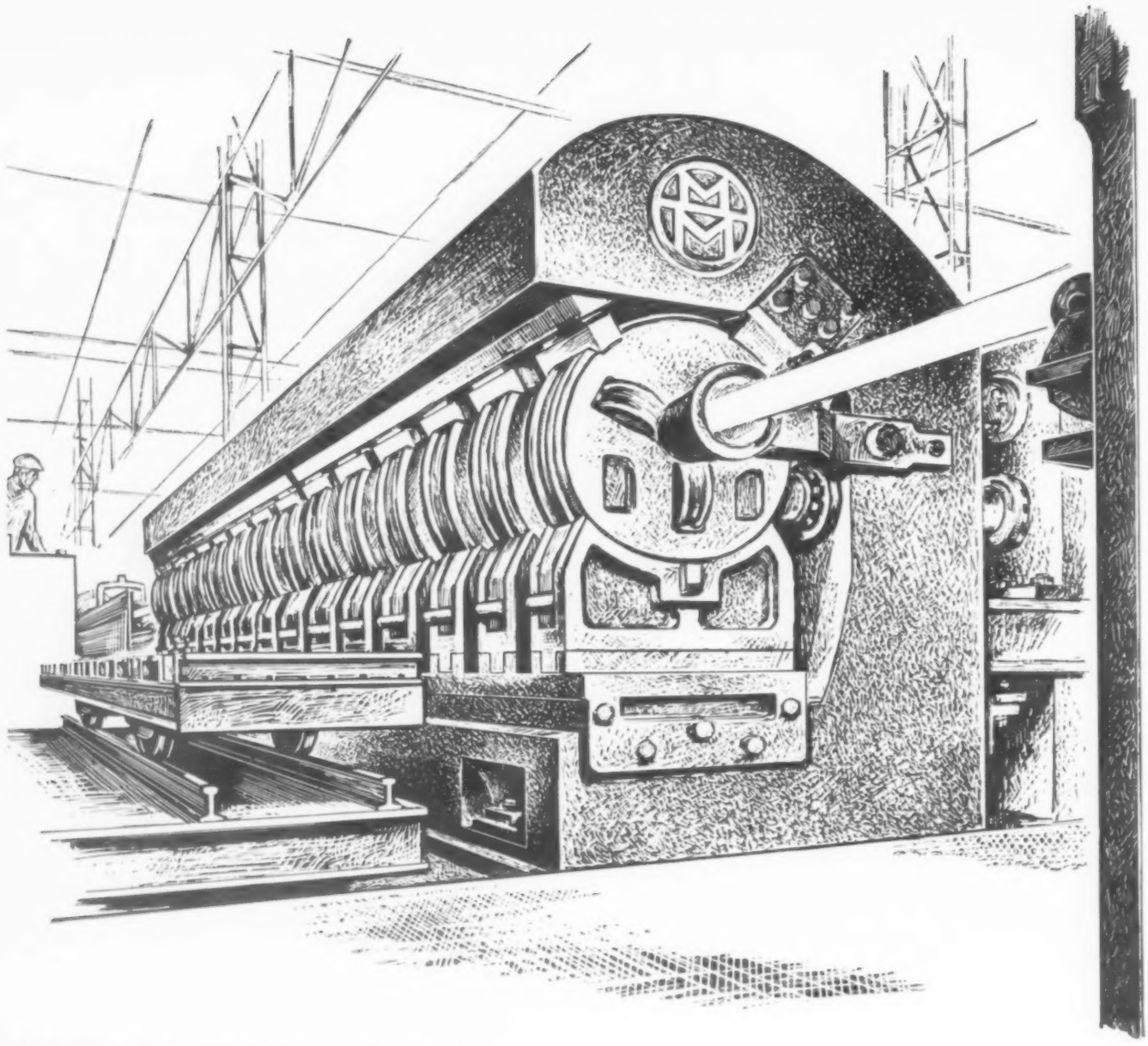


Want Higher Pipe Production?

Stretch reducing to increase tonnage rating of existing pipe welding mills or to increase the potential output of new mills is one of the recent production improvements at Mannesmann-Meer. Welding or rolling large diameter standard sizes boosts tonnage of the original mill and puts the stretch mill to work to produce the smaller sizes.

But that's only half of the story. By applying the 3-roll arrangement to the stretch reducing mill, greater diameter and outstandingly high wall reductions together with an improved mill finished product have been made possible. Moreover, basic changes in overall mill design include a revolutionary new mill drive and an ingenious roll stand arrangement to suit today's need for extremely fast schedule changeover.

Plan ahead and develop today what you will ask for tomorrow is Mannesmann-Meer's approach to the problems of the pipe and tube industry. This leads to the design of equipment incorporating a combination of

- CREATIVE ENGINEERING
- DESIGN EXPERIENCE
- OPERATING BACKGROUND
- AMERICAN MANUFACTURING SKILL

which is nowhere else availabie and ready to answer your questions.

MANNESMANN-MEER

ENGINEERING AND CONSTRUCTION COMPANY, 900 LINE STREET, EASTON, PENNA

WORLD SPECIALISTS IN HIGH-SPEED TUBE MILL MACHINERY

engineering and design for steel mills and other industries. Offices will be maintained in Cleveland and Youngstown, Ohio.

Henry M. Heyn and **Albert L. Hollinger** have been elected vice presidents of Surface Combustion Corp. Mr. Heyn has been sales manager of the Heat Treat Division since 1930. Mr. Hollinger has been manager of the Steel Mill Division since 1930.

Richard G. Widdows, who joined the Electric Controller & Manufacturing Co. in 1909, served as its president from 1943 to 1952, and as chairman of the board since that time, retired September 30 after 46 years of service.

Theodore F. Smith has joined Kaiser Engineers Division of Henry J. Kaiser Co. as industry consultant. He has been assigned to industrial development and will maintain offices at the firm's regional headquarters in Pittsburgh. Active in the iron and steel industry in Pa. for many years, Mr. Smith recently retired after 17 years as president of the Oliver Iron and Steel Corp. He had been associated with that corporation since 1936.

L. A. Fugassi has been appointed assistant chief engineer of Weirton Steel Co. Other appointments include **Joseph M. Bendot** as chief draftsman, **Judson W. Martt** as assistant chief draftsman, and **Lester J. Baird** as development engineer.

Thomas G. Roderich, chief industrial engineer, Steel and Tube Division, Timken Roller Bearing Co., retired September 1. Mr. Roderich came to Timken in 1927 from Bethlehem Steel Co. In 1929 he joined Empire Steel Co. as superintendent of open hearths, but returned to Timken in 1930.

Paul Kimble has been appointed Foreman — Electrical department of Wheeling Steel Corp. Mr. Kimble joined Wheeling as a motor inspector in the maintenance department, Martins Ferry Factory in 1947. In 1949, he was transferred to the Benwood works as an electrical wireman, returning to Martins Ferry the following year in that same capacity. Mr. Kimble remained in that position until his recent promotion.

Dr. Paul W. Bachman has been elected vice president and director of research and development for Koppers Co., Inc.

Dr. Jacob O. Kamm was elected president of the Cleveland Quarries Co. He has also been elected president of the company's wholly owned subsidiary, Silica Chemicals, Inc.

C. L. Peterson has been appointed vice president and general manager of the Brown Instruments Division, Minneapolis-Honeywell Regulator Co. He had formerly been divisional vice president.

V. L. Spinney, manager of Allis-Chalmers Manufacturing Co.'s New York district since 1949, has been named manager of the central region succeeding **R. L. Halsted,** who was recently appointed manager of the firm's processing machinery department. **N. W. Landis** is named manager of the New York district succeeding Mr. Spinney. **A. J. Mestier, Jr.,** succeeds Mr. Landis as manager at Detroit.

Ralph W. Updegraff, chief industrial engineer, Bearing Division, was named chief industrial engineer of the Timken Roller Bearing Co. **Ross Russell,** who has served as senior industrial engineer in the Bearing Division, was promoted to the post of divisional industrial engineer for the Steel and Tube Division.

Phillip A. Carlson was appointed regional manager of newly created midwestern sales region of SKF Industries, Inc. Mr. Carlson will be in charge of the Chicago, Milwaukee, Minneapolis and St. Louis sales territories.

Joseph H. Parsons, vice president of the Brake Shoe and Castings Division of American Brake Shoe Co., has retired after completing 42 years of service with the firm.

Jacques Yves Pierre Sejournet, managing director of Comptoir Industriel d'Etirage & Profilage de Metaux, Persan, France, is one of the 1955 recipients of the Franklin Institute's John Price Wetherill Medal. In making the announcement, **Dr. Henry B. Allen,** executive vice president, said Mr. Sejournet is being

HENRY M. HEYN

ALBERT L. HOLLINGER

RICHARD G. WIDDOWS

THEODORE F. SMITH

ARTHUR B. MORSE

GEORGE BAILLIE, JR.

E. W. BAUMGARDNER

ROBERT T. CONROY

recognized "In consideration of his invention of the Ugine-Sejournet Extrusion Process for metals — stressing the ingenious utilization of glass as a lubricant and the effective method of its uses."

Arthur B. Morse was named vice president and western sales manager of the Mexico Refractories Co. For the past five years, he has been California district manager for the company.

George Baillie, Jr., was named sales manager of the E. W. Bliss Co., Rolling Mill Division.

E. W. Baumgardner has been appointed sales manager of the Trabon Engineering Corp. Before joining Trabon, Mr. Baumgardner was associated for nine years with Industrial Ovens, Inc. He served as chief engineer, and for the past three years as sales manager. Prior to that time he was a design engineer with National Carbon Co.

Robert T. Conroy has been named assistant to the president of the Morgan Engineering Co.

Stanley M. Brown was named Philadelphia plant manager of Exide Industrial Division, the Electric Storage Battery Co.

Obituaries

J. LEDLIE MILLER

J. Ledlie Miller, assistant chief combustion engineer for Republic Steel Corp. died September 18. Mr. Miller had been employed in the steel industry since 1909, when he joined Carnegie Steel Co. as a messenger. He worked at Bellaire and at Follansbee Steel in Toronto, Ohio, before going to Wheeling Steel Corp. as fuel engineer in 1925. In 1928 he moved to the Ohio Works of Carnegie Steel at Youngstown, Ohio where he served as assistant chief engineer. In 1937 Mr. Miller joined Republic Steel Corp. at Cleveland. He served as president of the AISE in 1945.

Henry E. Warren, Jr., assistant general superintendent of the Fairless Works of the United States Steel Corp., died September 16. He was 43. Mr. Warren began his career with U. S. Steel in the metallurgical department of the Homestead Works in 1934. He progressed through various executive positions in the operating department, and in 1945 became division superintendent of open hearth furnaces —a position he occupied until transferred to the Fairless Works as assistant general superintendent in February, 1951.

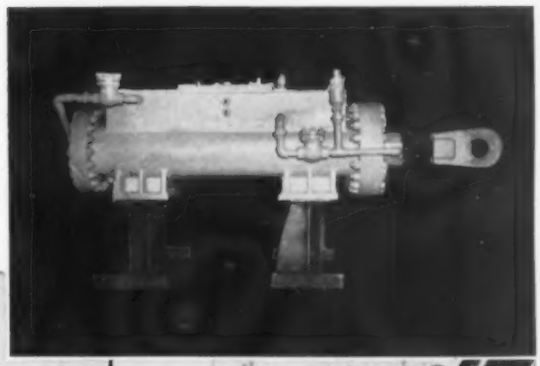
Ben L. Cook, district manager of the Timken Roller Bearing Co.'s Pittsburgh office, industrial division, died September 6. He was 47.

Bruce A. Stulginskis, electrical engineer for United Engineers and Constructors, Inc., died September 21.

James A. Slater, 42, sales engineer for the Rust Engineering Co. died September 3.

Now — DRAVO HYDRAULIC BUFFERS give safe stops on equipment runways

New hydraulic buffers, assuring positive, safe deceleration for all types of traveling equipment, have been developed by Dravo Corporation. In the event of braking failures due to mechanical or electrical reasons, or slippery rails caused by bad weather, the hydraulic buffer acts as an auxiliary brake and eliminates the possibility of severe damage to personnel and equipment plus the resulting repair costs and plant tie-ups.



the DRAVO six-foot-stroke Hydraulic Buffer →

An eastern steel producer installed this pull-type buffer on a 15-ton ore bridge where the 215,000-lb (loaded) man trolley has a top speed of 900 fpm. The trolley strikes a buffer beam connected to the twin buffers and is brought safely and smoothly to a complete stop within six feet. The buffers reset automatically when the trolley travel is reversed.

the DRAVO two-foot-stroke Hydraulic Buffer →

A midwest steel producer needed a smaller, lighter buffer because of space and weight considerations. Dravo designed a two-foot, push-type, direct-contact buffer to meet the requirements of this installation and to produce a safe, although more sudden, stop. A spring reset is used on this buffer.

If your operations are subject to costly accidents due to the need for safe stops of traveling equipment such as man trolleys, overhead cranes, cars, etc., get in touch with Dravo for complete information on the new hydraulic buffers.

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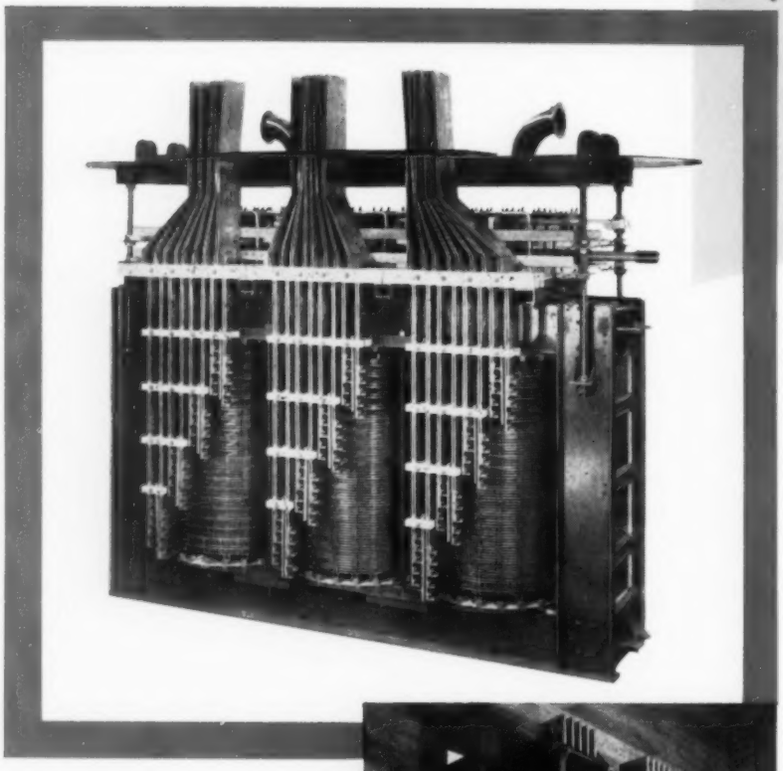
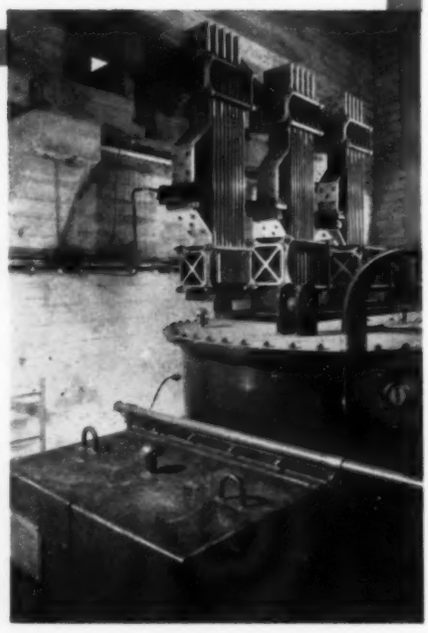
A Furnace Transformer Record by PENNSYLVANIA ....

No Low Voltage Breakdowns in 20 years



Low voltage side of a 25,000 Kva Pennsylvania Furnace Transformer. Three phase, 60 cycles, water-cooled. High voltage: 13,800 volts. Low voltage: 430 to 290 volts. Maximum line current 39,000 amps.



18,750 Kva Pennsylvania furnace transformer in service at a West Coast steel plant. Three phase, 60 cycles, forced-oil/water-cooled. High Voltage: 6600 volts. Low Voltage: 375 to 144 volts. Maximum line current: 33,300 amps.

In 1936 Pennsylvania introduced a new type of helical winding in the low voltage coils of a 2500-kva furnace transformer. Since then, the same principles of coil design have been incorporated in scores of Pennsylvania furnace transformers. These furnace transformers have ranged in size from 250 through 25,000 kva, and from 3175 through 57,735 amps.

This wide range of sizes demonstrates Pennsylvania's complete familiarity and experience with furnace transformer application. Even more important, however, is the record of performance achieved over this entire range — a 20-year record which reveals that there has **never been a low voltage breakdown** on any Pennsylvania furnace transformer utilizing the exclusive helical coil design.

With a background such as this, in both experience and **proved performance,** Pennsylvania Transformer Company is well qualified to satisfy today's highly exacting furnace transformer requirements. Whether you buy your next furnace transformer separately or as part of an installation "package", why not make certain of long-range dependability by specifying Pennsylvania?

PENNSYLVANIA TRANSFORMER COMPANY

A McGraw Electric Company Division • **CANONSBURG** • **PENNA.** • *Greater Pittsburgh District*

Modern Steel Makers Maintain Control with RCA Industrial TV

Production records are being made through mill supervision by RCA Industrial TV . . . On an 80" mill that holds the world's record for hot strip, a camera over the mill and a TV screen on the control pulpit permit the operator to detect threats of pile-ups, or other troubles, before damage occurs. One pile-up on a strip mill can mean as much as 15 minutes of lost production time or 120 tons of steel . . . so it pays off handsomely to KNOW, not GUESS.

Many Uses. Other uses include RCA Industrial TV to observe furnace conditions, heat treating, charging, crane movement, and other hazardous or inaccessible operations . . . wherever it's important to *see* where you cannot *look.*

Direct-Observation Clarity. With RCA Industrial TV you attain the accuracy of direct observation without danger or inconvenience. You see a high-definition, high-contrast picture that's best for efficient centralized control, and all camera adjustments are conveniently made at the viewing monitor.

Survey Without Obligation. Let us make a survey of your Industrial TV requirements without obligation. RCA's practical Service Plan provides for service by experienced factory-trained engineers. Use coupon below for literature.

RCA CAMERA . . . compact, rugged, built to give reliable service under rough operating conditions. Uses the sensitive RCA-developed time-proved Vidicon tube, reducing weight to a minimum.

RCA MONITOR . . . shows stable, high-definition picture, assures accurate reproduction of fine details. For convenience and ease of operation, all controls for camera and TV are located on control monitor.

ACCESSORIES . . . include water-cooled camera lens, explosion-proof housing, panel-mounting monitor, camera switcher, industrialized auxiliary viewer, remote iris, remote focus, pan and tilt assembly and other field-proved equipment.

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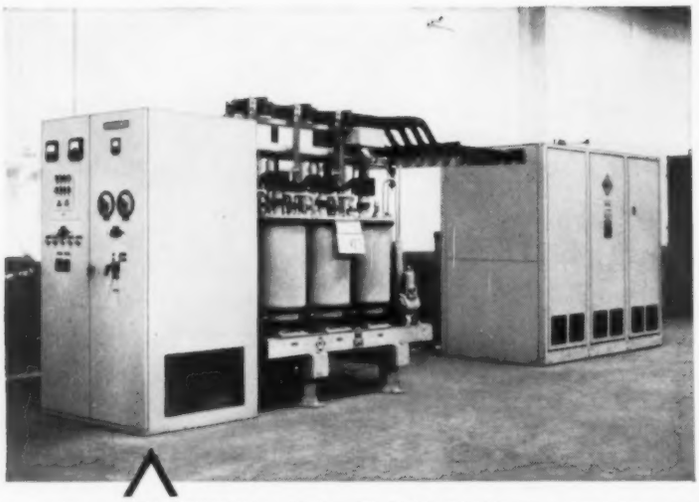
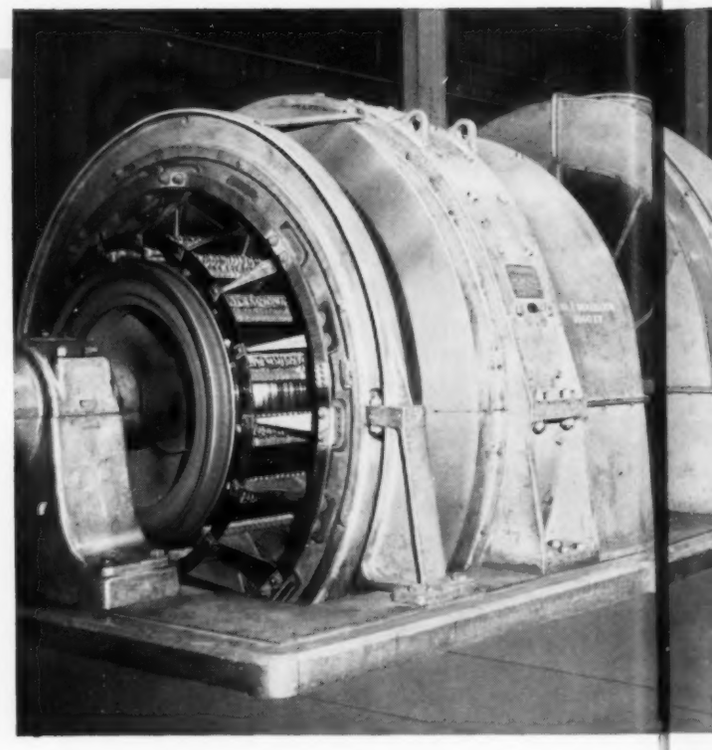
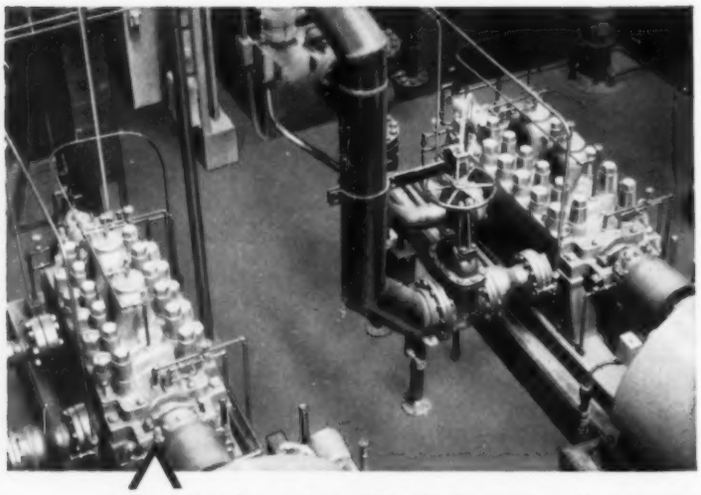
Helping Youngstown Top Steel Year After

ALLIS-CHALMERS Steel Mill EQUIPMENT



This 1000-kw, 250-volt Allis-Chalmers mercury arc rectifier furnishes direct current to cold mill auxiliaries. An additional low-first-cost, high efficiency unit of this type and capacity is being installed in the tin mill.



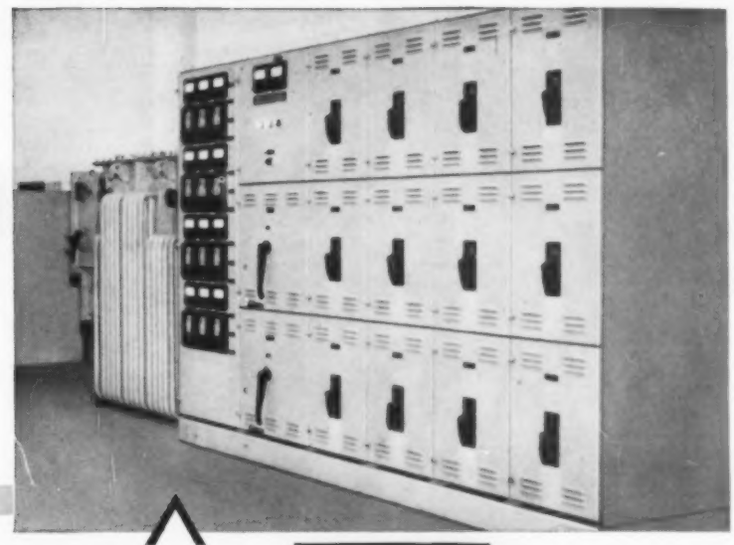


Two 6 by 4 five-stage Allis-Chalmers descaling pumps rated 1000 gpm, 1140 psi. Allis-Chalmers has also furnished fire pumps, motors and controls for other applications at the Indiana Harbor mill.

Equipment Installed in 1940 Still Going Strong as new Equipment is Added to Keep Pace with Today's Production and Quality Requirements

A-C ALLIS-CHALMERS **ALLIS-**

Obtain Production Year



Allis-Chalmers 1000-kva, 440-volt substation serves the cold mill at Youngstown's Indiana Harbor Works. Unit has non-flammable *Chlorextol* liquid-filled transformer. Additional substations of larger capacity are now being furnished for expansion at this plant.

These two Allis-Chalmers 6000-kw, 600-volt motor-generator sets supporting the 54-inch hot strip mill have been operating at rated capacity and above for 15 years — with minimum maintenance.

SWITCHGEAR, transformer, substation, and rectifier equipment was recently added to the growing list of Allis-Chalmers installations at The Youngstown Sheet and Tube Company's Indiana Harbor Works. These Allis-Chalmers units were specified for the new cold mill that is part of the major expansion program at the Indiana Harbor plant.

For many years, Allis-Chalmers equipment has served Youngstown well. Motor-generator sets, motors, pumps, *Texrope* drives, transformers, switchgear—all have been supplied over the years to help keep production at The Youngstown Sheet and Tube Company plants modern, flexible and economical.

You too can take advantage of the wide range of Allis-Chalmers products and superior service . . . backed by experience gained serving the steel industry since the days of the famed Corliss engine drives. For help in planning new facilities or modernizing present plants, contact the A-C office in your district, or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-4836

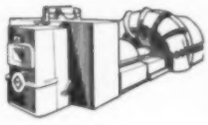
CHALMERS

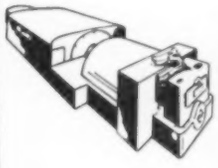
Other

Allis-Chalmers Equipment for the Steel Industry

Wide Range of Motors for main mill and auxiliary drives — ac or dc — from 1 hp to 10,000 hp — and supporting rectifiers or m-g sets.

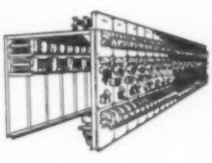
Blast Furnace Blowers are an important part of the complete A-C line of single and multi-stage centrifugal blowers, axial and rotary compressors, and vacuum pumps for the steel industry.





Power Generation Equipment includes steam turbine-generator units 2000 kw and larger for fluctuating steel mill loads. Also condensers, pumps and auxiliary drive motors.

Steel Mill Control offered by Allis-Chalmers includes constant potential and variable voltage systems, magnetic amplifier, electronic and mechanical regulators, and liquid rheostats.



Chlorextol and *Texrope* are Allis-Chalmers trademarks.

Meet the BIRDSBORO Roll Specialist . . .

. . . he comes to you backed by over a half century of metallurgical, engineering, and production experience. Birdsboro's long record of producing specialized steel, alloy iron, and alloy steel rolls stands behind him to give you individualized roll service. When you want the outstanding performance that means increased tonnage, call BIRDSBORO.

IRON BASE ROLLS: Grainloy, Birdsboro Metal, Curoloy, Superloy, Super Curoloy.

STEEL BASE ROLLS: Diamondite, Birdsboro Special, Birdsboro "30", "40", "50", and "75".

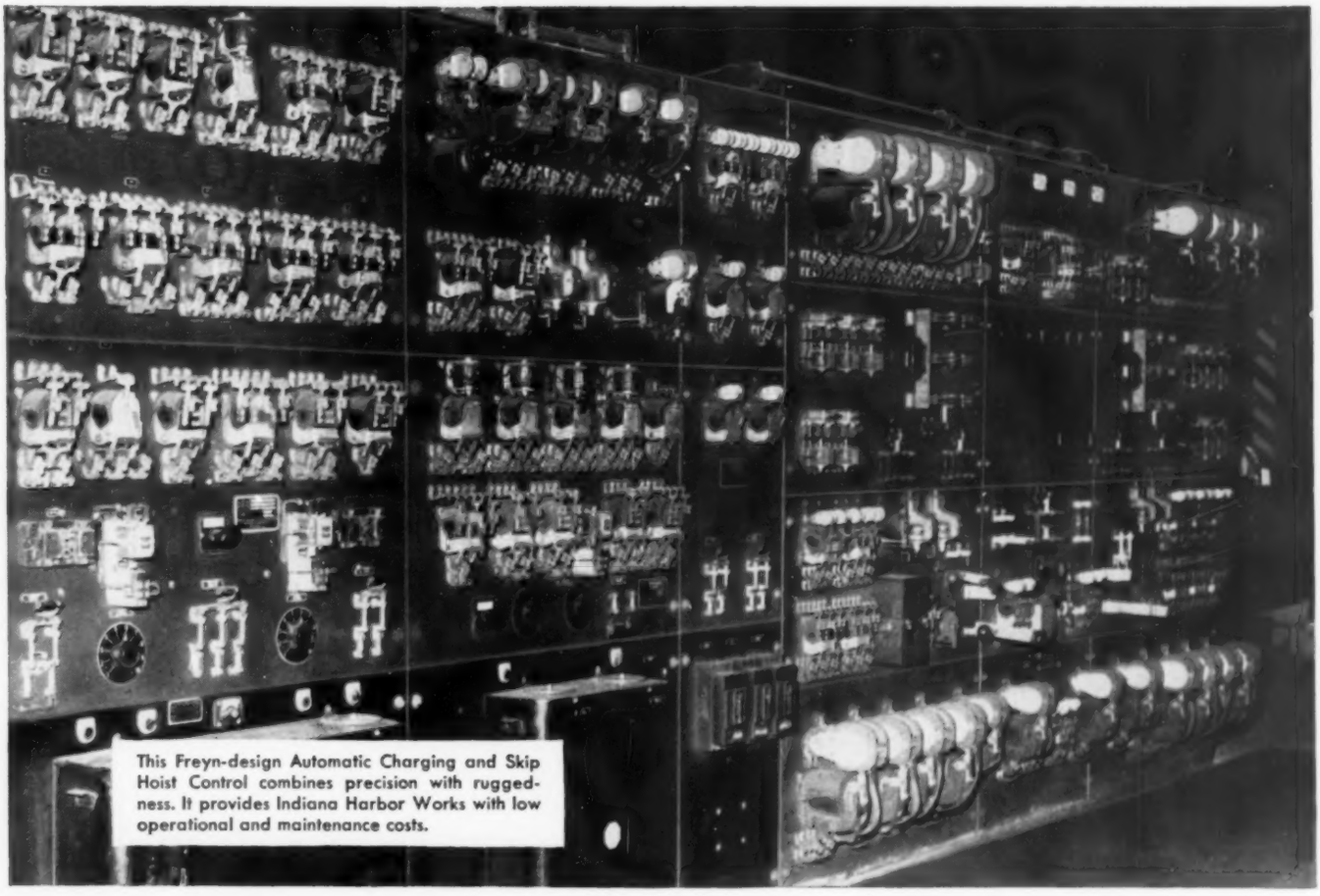
Designers and Builders of:

STEEL MILL MACHINERY
HYDRAULIC PRESSES
CRUSHING MACHINERY
SPECIAL MACHINERY
STEEL CASTINGS
Weldments "CAST-WELD" Design
ROLLS: Steel, Alloy Iron, Alloy Steel

R-10-55

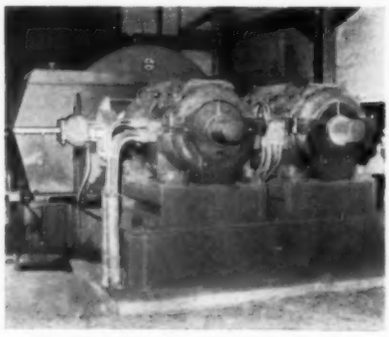
BIRDSBORO

BIRDSBORO STEEL FOUNDRY & MACHINE CO., BIRDSBORO, PENNA. Offices in Birdsboro, Pa. and Pittsburgh, Pa.



This Freyn-design Automatic Charging and Skip Hoist Control combines precision with ruggedness. It provides Indiana Harbor Works with low operational and maintenance costs.

Freyn-Design Combines Precision, Ruggedness in Automatic Blast Furnace Control



Freyn-design Skip Hoist (illustrated above), Chimney Valve (illustrated below), Bell Hoist and Stockline Recorder (not illustrated) make a compact, efficient, high production team.

At The Youngstown Sheet & Tube's
Indiana Harbor Works

Choosing the controls and equipment which would best handle the charging operation of their new No. 3 blast furnace at Indiana Harbor Works, East Chicago, Indiana presented no problem to The Youngstown Sheet and Tube Company—they chose Freyn-design controls and equipment. And here's why: First, because Freyn built-in precision offers safe, accurate operation. Second, because Freyn ruggedness gives years of dependable, trouble-free service. Third, because Freyn-design controls and equipment provide maximum production at lowest cost.

Proof of the ability of Freyn control equipment to provide precision and ruggedness plus efficient, low-cost operation is evidenced in Freyn installations in blast furnaces on every continent.

Freyn-design blast furnace equipment installed at Indiana Harbor Works adds to the already long—and continually growing—list of Freyn installations throughout the world. Freyn has—for over forty years—been the standard in blast furnace equipment. We invite you to consult with our engineers and management.

KOPPERS®

KOPPERS COMPANY, INC.

Freyn Department

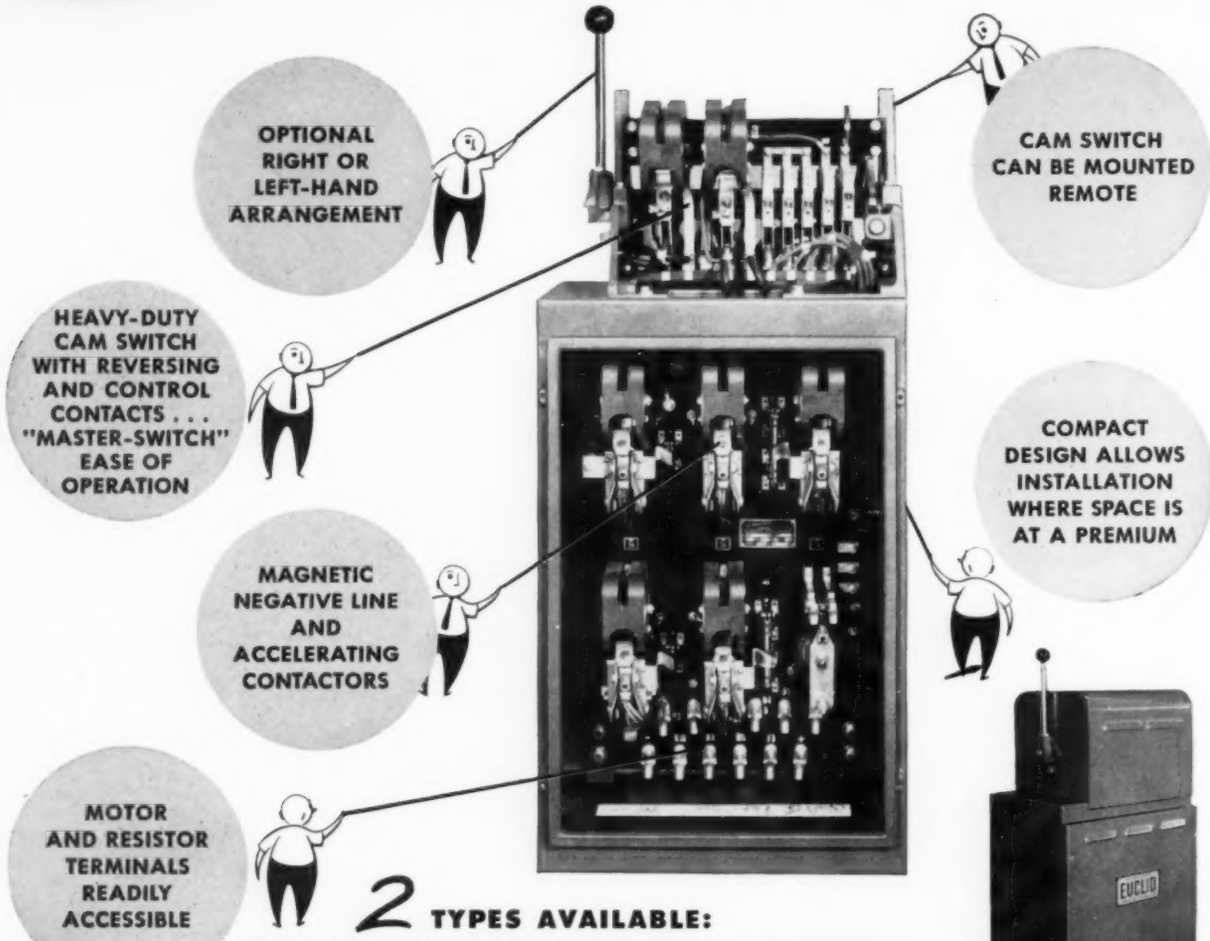
Engineering & Construction Division

KOPPERS BUILDING • PITTSBURGH 19 *Associated with* Ashmore, Benson Pease & Co. Ltd., Stockton-on-Tees, ENGLAND; De Laitre & Frouard, Paris, FRANCE

NEW

HEAVY-DUTY D-C MAN-NETIC CONTROLLERS*

Combination Manual and Magnetic Controller for Cranes . . . Charging Machines . . . D-C Control Jobs


OPTIONAL RIGHT OR LEFT-HAND ARRANGEMENT
CAM SWITCH CAN BE MOUNTED REMOTE
HEAVY-DUTY CAM SWITCH WITH REVERSING AND CONTROL CONTACTS . . . "MASTER-SWITCH" EASE OF OPERATION
COMPACT DESIGN ALLOWS INSTALLATION WHERE SPACE IS AT A PREMIUM
MAGNETIC NEGATIVE LINE AND ACCELERATING CONTACTORS
MOTOR AND RESISTOR TERMINALS READILY ACCESSIBLE
EUCLID
TOE SPACE FOR OPERATOR'S COMFORT

2 TYPES AVAILABLE:

REVERSE-PLUGGING OR DYNAMIC-LOWERING

Provide four speed points, reversing, with all advantages of full-magnetic control. Manually-operated cam contacts are free of destructive arcing . . . extremely fast magnetic contactor action interrupts power circuit before cam-operated contacts are opened. EUCLID'S EXCLUSIVE "TIMELOK" feature offers maximum dependable acceleration timing without extra relays . . . permits unusually compact arrangement of the magnetic panel.

For more information, contact our representative in your area, or write or call THE EUCLID ELECTRIC & MFG. CO., MADISON, OHIO.

Ask for Bulletin 4400-4401.

*PATENT APPLIED FOR

THE EUCLID ELECTRIC & MFG. CO.
MADISON, OHIO

THE EUCLID ELECTRIC
EUCLID
AND MFG. CO., MADISON, OHIO

It's in the Bag!

Fresh, Clean Ink for a Year of Trouble-free Recording

★ You won't have any messy, time-consuming re-inking of pens on the new Bailey Recorders. The entire system is white-glove clean—hermetically sealed, non-evaporating, non-corrosive. Gone is any chance of sludge or oxide formation. Gone are clogged pens, interrupted records, unsightly splashes.

The transparent plastic ink sacs are changed once a year—that's all. Capillary tubing carries fresh, clean ink to the pens continuously without any day-to-day attention.

This exclusive new inking system* is only one of the many time-saving, money-saving distinctive features of the new Bailey Recorder.

Ask for Product Specification E12-5. P34-1

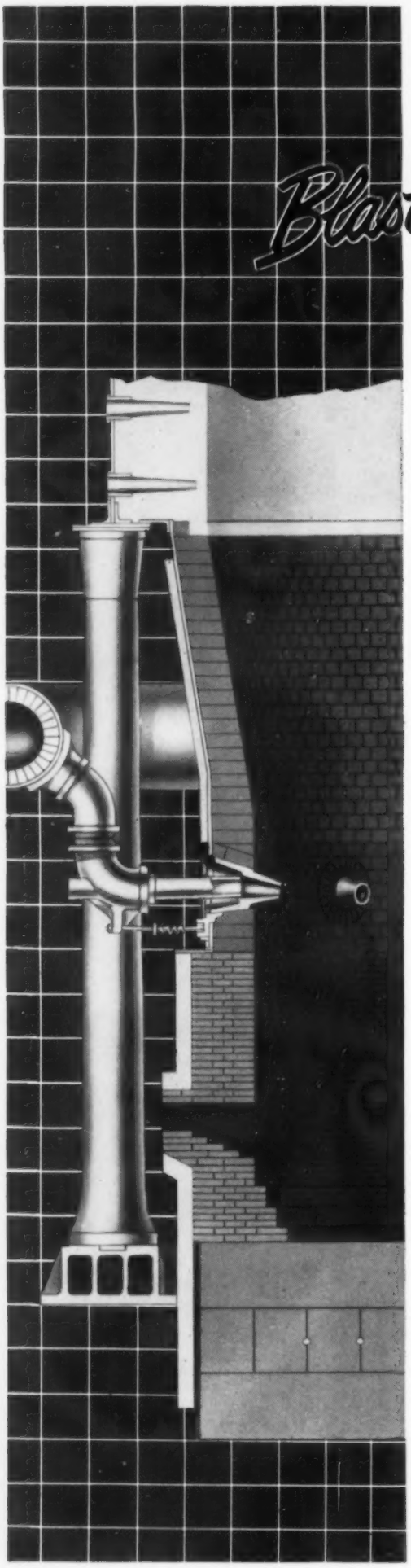
*Now available for the New Bailey Recorder only.

ONLY BAILEY OFFERS ALL THESE ADVANTAGES IN A SINGLE RECORDER

- Pre-calibrated plug-in receiver units
- Up to four pneumatic or electronic receivers —or two receivers and two integrators
- Any four variables on one chart—easily read and interpreted
- A full year's ink supply at one loading
- Faster ordering—from stock
- Minimum inventory of parts
- Minimum instrument investment for process cycle expansion or alteration

BAILEY METER COMPANY
1047 IVANHOE ROAD
CLEVELAND 10, OHIO
Controls for Power and Process

BAILEY METERS
Controls for
TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW · LEVEL
RATIO · DENSITY



Blast Furnace Capacities Increased up to 20%

WITH

NATIONAL
TRADE-MARK

CARBON LININGS

Increases of up to 20 per cent in rated furnace capacity have been achieved when carbon linings were installed up to the mantle — *within the same hearth and under the existing stack shell.* These increases were possible because of the superior refractoriness of carbon, which permits thinner wall constructions with consequent enlargement of inside furnace diameters.

Numerous construction cost analyses have shown initial installation of these "National" Carbon Linings to be more economical because internal cooling is eliminated, which results in much lower maintenance and operating costs.

In addition, "National" Carbon Linings maintain a smooth inner face with freedom from adherence which also helps to improve operating efficiency.

We will be glad to have our representative call at your convenience to supply complete information on "National" Carbon Linings for Blast Furnaces.

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N.Y.

Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco

IN CANADA: Union Carbide Canada Limited, Toronto

Equipment News...

LATHE

▲ An electronically-controlled contour turning lathe which can finish and redress mill rolls in a fraction of the time needed with conventional roll lathes has been developed by Mackintosh-Hemphill Div., E. W. Bliss Co.

The new lathe, of nominal 48-in. swing, will be used for work on shape rolls up to 18 ft long with outside rough diameters as great as 50-in.

The lathe is fully automatic in operation. Its carbide cutting tool is moved by independent long-feed and cross-feed motors reproducing on the roll body required contours identical with those of a full-sized template through stylus contact with template. The control provided by this arrangement is so precise that reproduction accuracy can be held to 0.001-in. Smooth cuts can be made on a shoulder normal to the axis of the roll, a virtual impossibility with contouring lathes equipped with other types of automatic controls.

The new lathe removes up to nine times as fast as manually-controlled roll lathes. It can operate continuously through maximum cut depth of ⅞-in. with feeds of .060-in. to .100-in. or greater.

While the new lathe is similar to earlier types, it incorporates several design improvements. For instance, the tool holder has been strengthened for greater resistance to sidewise deflection under heavy cutting loads. All headstock gears are double-helical, providing smooth, quiet operation and maximum torque capacity. The tailstock has been redesigned to incorporate a large, built-in, anti-friction live center with increased load capacity.

Traversing is faster and easier, since both feed and traverse operations are obtained through a single, large-diameter feed screw.

Recently installed at Inland Steel Co.'s Indiana Harbor works, this electronically-controlled turning lathe is said to do the work of three to four lighter duplicating lathes, producing greater accuracy than the finished roll passes.

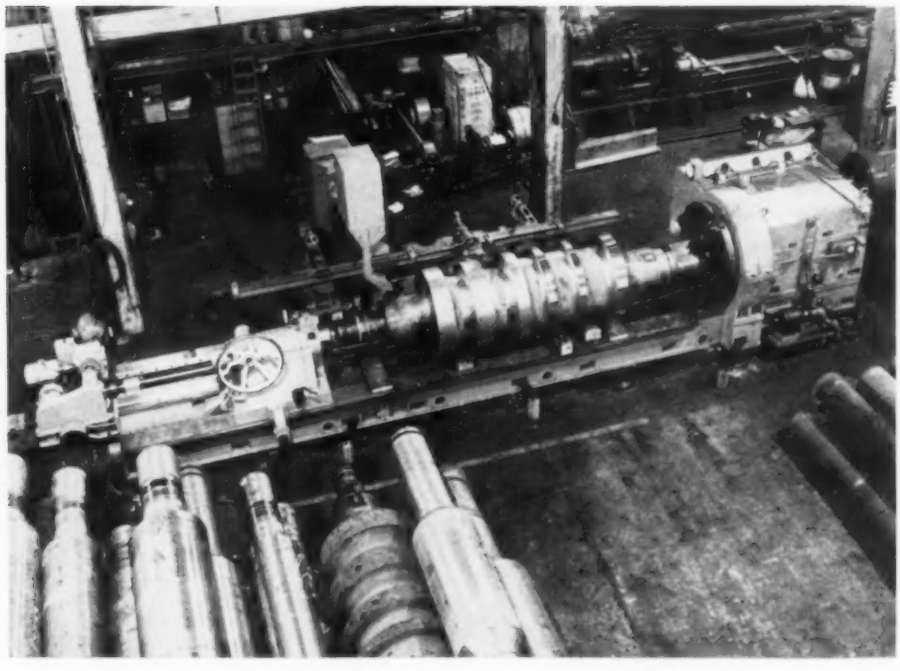
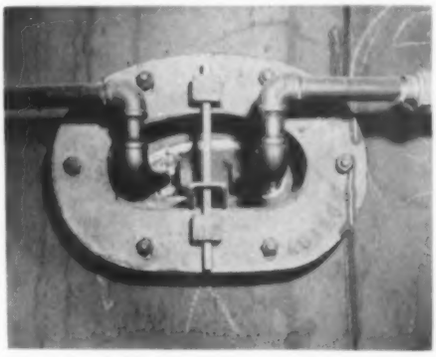


PLATE HOLDER

▲ Introduced by William M. Bailey Co., is an improved blast furnace cooling-plate holder. This unit has two main parts—the cooling plate and its holder, and the nozzle through which the cooling plate is inserted into the furnace brickwork. This cooling-plate holder is adaptable for new or relined furnaces.

One feature of this unit is the ease of removal of cooling plates for inspection or replacement. The plate can be removed from outside the furnace, simply by removing water connections and flange bolts. The cooling-plate holder is gas and water tight. It is adjustable horizontally for maximum contact between brick and plates, and has an effective device for locking-in the cooling plate.



The unit is adjustable and only one size holder is used on all blast furnaces. It can be used on either welded or riveted shells. In the case of riveted shells the cooling-plate holder can be located closer to the lap joints than other types of holders.

ARMORED MOTORS

▲ General Electric Co., has developed an improved line of direct current armored motors with an advanced insulation utilizing Class H materials.

The new insulation will withstand temperatures of 180 C. Its use in normal duty virtually eliminates insulation failure as the limiting factor in continuous armored motor service.

The new insulation system, which includes the application of a specially developed silicone varnish, was installed in the MD-602 model for tests in which the motor was subjected to severe overloads which produced motor temperatures as high as 200 C.

Connected to it was another MD-602 with the former Class B type insulation. To maintain an equal balance between them in both load and temperature, the two motors alternately functioned as motor and generator.

The motors were driven at four times their rated speed and subjected to severe vibration. The shunt field circuit was abruptly interrupted at regular intervals to produce an in-

ductive kick which would throw electrical stress on the field coil insulation.

The tests showed the Class H insulated motor maintained excellent operating condition without apparent loss of dielectric or physical strength, contrasted with extensive burn-out damage in the motor with Class B insulation.

Demonstrated by the tests was the ability of the Class H insulated motor to outlast at least two Class B insulated motors. Engineers calculate that under identical operating conditions, Class H insulation will outlast Class B by as much as 32-to-one.

Class H insulation has been adapted to three main sections of the armored motor—the field coils, armature coils and the main area of the armature insulation. In all these sections damage has resulted in the past from high heat concentration.

GLOBE VALVE

▲ A new globe valve, especially designed and recommended for use on liquid-immersed electrical transformers, has been developed by Crane Co.

The valve comes in ¾, 1½ and 2-in. sizes and is rated for 150 lb maximum pressure at 200 F maximum temperature.

It has a screwed bonnet, an integral semi-crown seat, spun-on connection between stem and disc holder and a synthetic-base composition disc that is highly efficient in transformer oil service. A boss on the outlet side can be tapped for insertion of a ⅜-in. vent valve.

WELDING UNITS

▲ The Harnischfeger Corp. offers a new line of 500, 750, and 1200-amp. constant-voltage welders which allow the operator to select the arc voltage he desires. This voltage then remains constant during the entire welding cycle. All the operator must do is set the correct rod feed and travel rate to get the desired deposit rate. The constant voltage feature insures that the deposit is uniform; arc voltage, rod speed and travel rate all remain constant.

Weld quality is enhanced because starting and recovery are instantaneous even where tack welds and areas of poor fit-up are encountered. Hunting is eliminated.

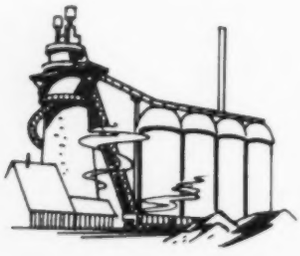
These units achieve an efficiency of 85 per cent or better, resulting in lower installation wiring costs and savings in power. On field welding jobs where power must be supplied by engine-driven generators, it is reported the use of these constant voltage welders has often doubled the welding capacity from the same power source. The company has jobtested the units on such automatic welding processes as: submerged arc, inert gas, semi-automatic, hard-surfacing, automatic stud welding and low-current density welding.

PRIMARY BATTERY

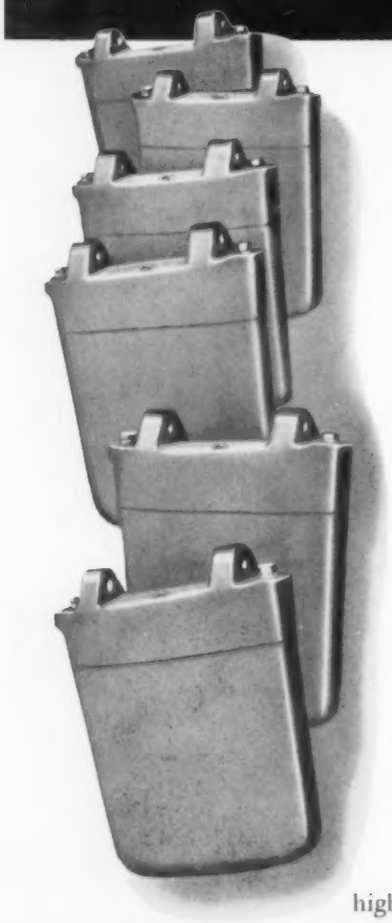
▲ National Carbon Co., has announced an air depolarized primary battery built for minimum service life of one full year.

The new switch lamp battery provides the following outstanding advantages: lowest maintenance cost, lowest cost per amp hour, unrivaled low temperature performance, greater capacity with long life, uniform

Lawrence
COPPER COOLING PLATES



for your NEXT CAMPAIGN



If faulty cooling plates are giving you trouble, replace them with Lawrence Copper Bosh or Mantle Plates.

Lawrence Cooling Plates, made from pure copper with the know-how gained from 67 years in serving many of America's large steel plants, are your assurance of dependable, trouble-free performance throughout the campaign.

Send us your specifications today. We are at your service.

PURE COPPER CASTINGS
Tuyeres • Tuyere Coolers
Cinder Notches
Valve Gates and Seats

BRASS AND BRONZE CASTINGS
(Heavy type — 1 to 2 ton)
Bearings • Machinery Bronze
Bars and Bushings

highest *Quality & Dependability* since 1888

LAWRENCE COPPER & BRONZE CO.
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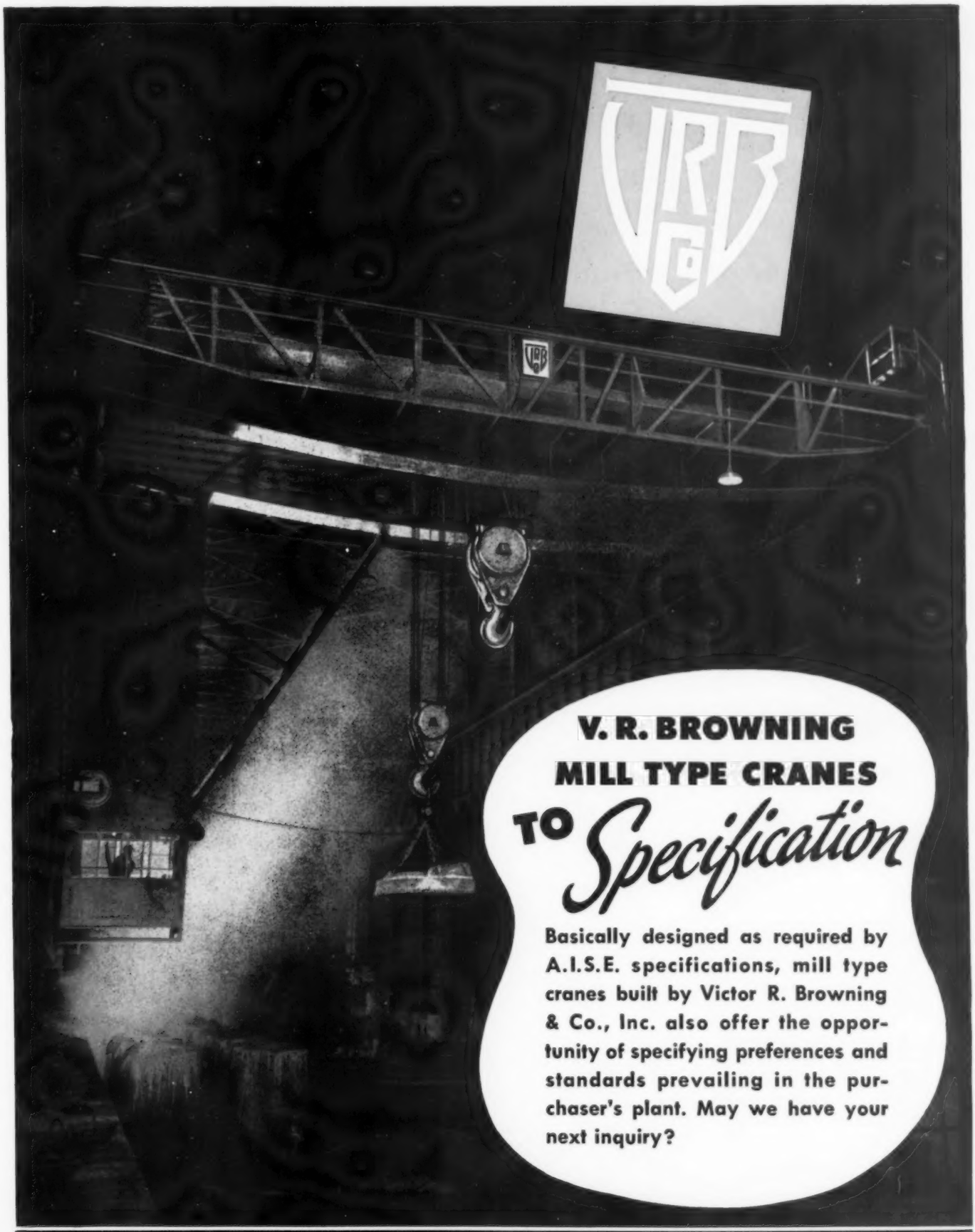

V. R. BROWNING
MILL TYPE CRANES
TO Specification
Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

VICTOR R. BROWNING & COMPANY, Inc.

BOX 309, WILLOUGHBY (CLEVELAND), OHIO

Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

HERE'S THE USG® BRUSH THAT DOES AN OUTSTANDING JOB ON ALL YOUR MILL MOTORS

When you replace the brushes on your mill motors, you can get the best results with USG Grade 135 Brush with Statite®. For brushes that give superb results in other applications, see below. Write for your copy of the complete USG Brush catalog today.

A typical USG Grade 135 Mill Motor Brush with Statite*

USG Grade 1658 Brush for tin line collector rolls

USG Grade 223 Brush for DC crane motors with Statite*

USG Grade AH897 Brush for Welding generators with Statite*

USG Grade 550 for AC Crane Motor Rings

*Permanent shunt connection, needing no hammerclips; cannot be jarred loose or pulled out.

203

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

voltage over entire life span, and standard AAR terminals. It was designed and developed by signal battery experts to answer requests for a disposable switch lamp lighting primary battery having a "one year changeout" plus ample safety cushion to permit flexibility in change out schedules.

Because the carbon-to-air contact has been so greatly improved and enlarged for more efficient depolarization the battery, known as CG-212, will deliver its rated capacity at continuous drains up to 0.300 amp at a solution temperature of 70 F. One battery will operate several switch lamps simultaneously as the voltage curve remains nearly flat throughout the battery's long useful life.

CRANE CONTROL

▲ A standardized light industrial crane control has been developed by Westinghouse Electric Corp. to convert infrequently used cranes from cab to pendant operation. Advantages of the control include flexibility, low cost and ease of maintenance.

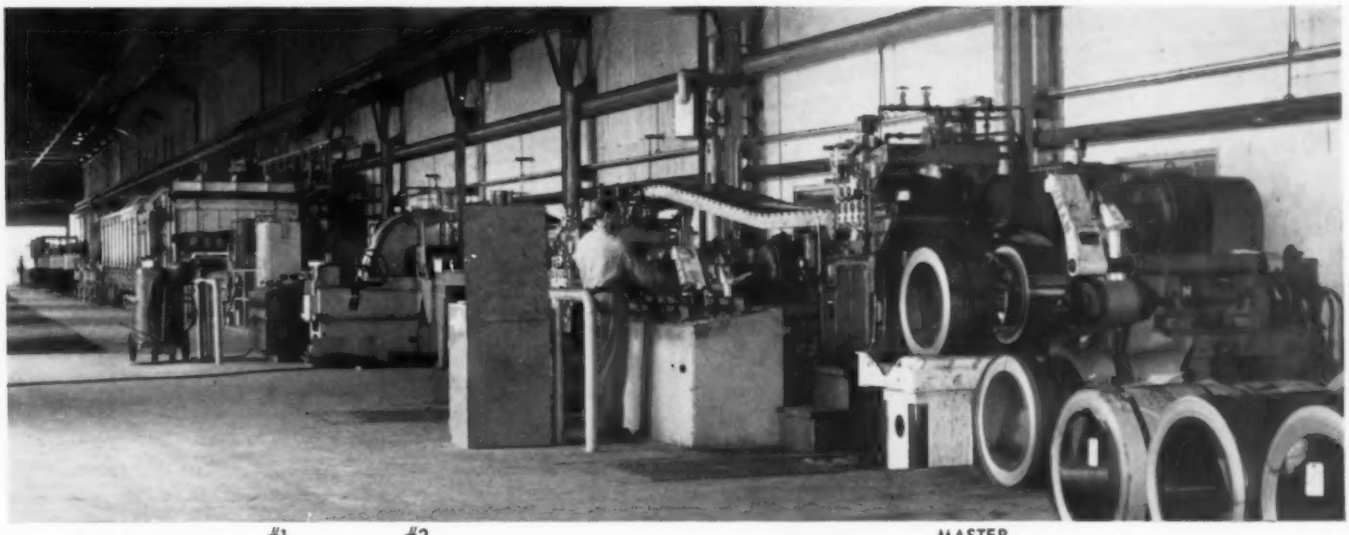
Trolley, bridge and hoist controls can be mounted individually, or in a group. Less expensive and lighter components are front mounted and wired on a steel panel. Contactors, timers and relays can be removed without taking the panel off. Resistors are rear mounted. The controllers are in individual steel cabinets 20¼ in. high by 13 in. deep and varying in width to suit the control.

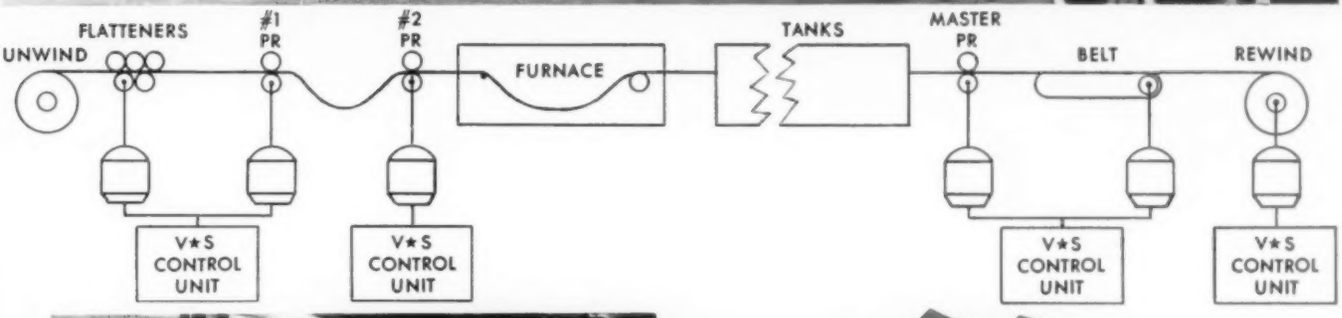
The control is available for both alternating and direct current applications, and also is adaptable for cab operation.

STRADDLE TRUCK

▲ Introduced by the Ross Carrier Division of Clark Equipment Co. is a straddle carrier with load hooks which pivot inward to permit carrying without bolsters.

In place of the conventional rigid load hooks, the carrier has four forks, two on each side, which swing in at right angles and meet in the center to form two arms under the load. Pivoting movement is controlled by hydraulic cylinders actuated by a lever on the left side of the driver's seat. A second lever hydraulically controls the vertical movement of the hooks.





Pickling Line V★S Drive Control Units

RELIANCE V★S DRIVE ®

PACKAGED DRIVES KEEP STAINLESS ON THE MOVE

As much as 14 miles of stainless steel strip is processed each day on the Atlas Steels, Ltd. two-strand pickling line . . . Canada's first continuous stainless steel pickling line.

Because this is a large stainless line requiring special care to prevent surface marring or scratching, consideration had to be given to the drive system. The drive requirements were for precisely controlled tension over wide speed ranges with extremely reliable control. Reliance V★S Drives with built-in electronic regulators keep the line moving and afford the flexibility to permit line speeds from 5 to 50 feet per minute for strip .007 to .187 inches thick and 10 to 20 inches wide.

Four compact V★S Control Units which house the factory-wired motor-generator sets and the control panels supply power to the motors for each half of the twin line. The "packaged" feature of the drive means extreme ease of installation and a great saving in installation cost plus the ability to tailor the drive system to the actual requirements. This "tailoring" meant that wide constant-horsepower speed range motors could be used to fit in with the line speed variables. These variables were created by the need for running strip of varying thicknesses and widths through the line at speeds dictated by the annealing furnace "constant tons per hour" limits.

This is a good example of the ability of Reliance to tailor drive systems to the specific application requirements of the steel industry. Write for Bulletin A-1555. D-1502-A

RELIANCE ELECTRIC AND ENGINEERING CO.

Cleveland 10, Ohio • Offices in Principal Cities

Canadian Division: Welland, Ontario

Builders of the Tools of Automation

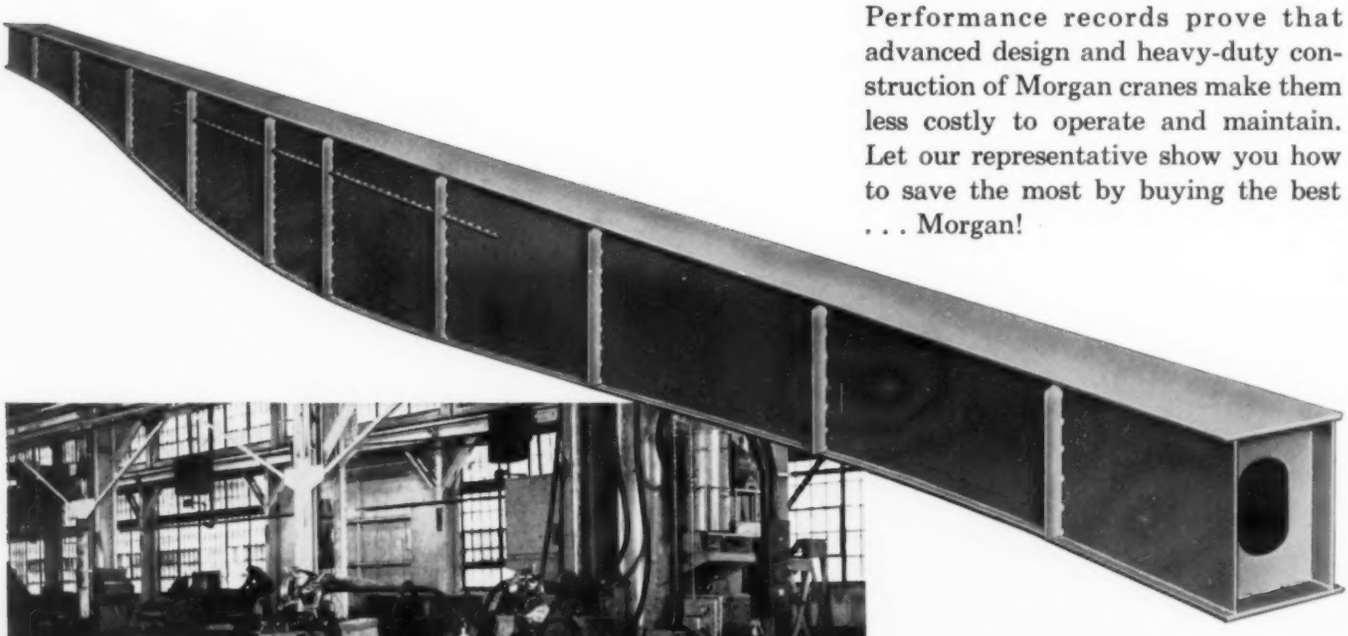
How Morgan cranes get a stiffer backbone ...automatically

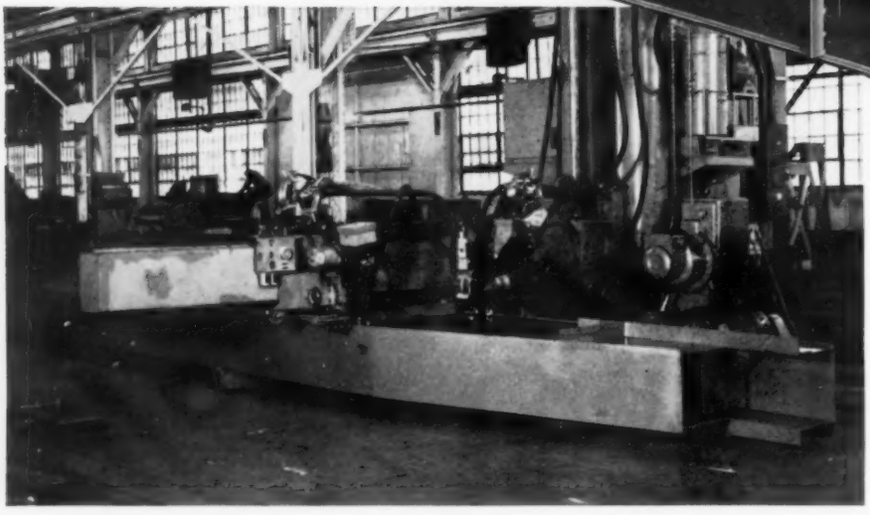
● MORGAN CRANES are stronger, more rigid . . . because girder joints and seams are welded automatically on the world's largest continuous welder. Casting imperfections and hand welding variables are eliminated with Morgan automatic welding. All joints are uniform and sound.

Crane drums, too, are welded automatically, making them stronger and lighter. Casting shrinkage voids are eliminated.

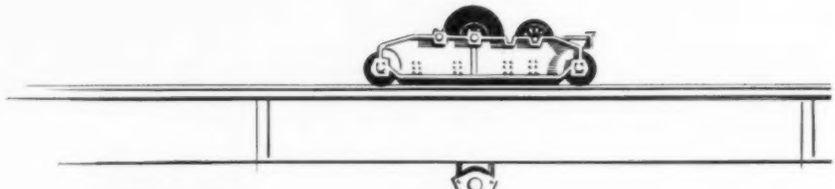
Morgan welders are qualified in accordance with A.S.M.E. and A.W.S. codes.

Performance records prove that advanced design and heavy-duty construction of Morgan cranes make them less costly to operate and maintain. Let our representative show you how to save the most by buying the best . . . Morgan!





Perfect welding penetration is obtained with Morgan's 120" per minute automatic welder. Two welding heads float vertically and horizontally along the track.



THE MORGAN ENGINEERING CO. *Alliance, Ohio*

The Morgan Engineering Company manufactures overhead electric traveling cranes, gantry cranes, charging machines, plate mills, blooming mills, structural mills, shears and saws.

Since the hooks extend under the full width of the load, no bolsters are necessary. Permanent skids or stringers are required only at the pick-up and delivery points.

The unit has a capacity of 20,000 lb, road speeds up to 40 mph, four-wheel steering, and a four-speed synchromesh transmission. Central positioning of the driver's seat gives 360 degree visibility. The pivoted hook mechanism is mounted in vertical roller slides equipped with anti-friction bearings. Hooks are mounted in bronze bushings.

The carrier is available in six models capable of carrying loads ranging in height from 48 to 66 in. and in width from 40 to 52 in.

MARKING UNIT

▲ For intermittent, light-duty general purpose marking, Jas. H. Matthews & Co. introduces its new Model 27 bench-mounted marking machine.

Manually operated, this unit uses either roller dies for marking flat parts, or flat-roll dies for marking round parts, and will indent one line of characters ⅛ in. or smaller on parts of suitable size, shape and workability. It is also available with flat-roll holders or mortised roller dies for quick, interchangeable marking with Matthews Steel Type. Special holding fixtures can also be furnished, so that the part is kept in perfect control during the marking operation.

The unit is easily mounted on a work table. The operator is in full view of the part and the marking dies or type during the marking operation, which is accomplished by a downward pull of the handle, removal of the marked part and raising the handle to return dies to the starting position. Marking depth is easily adjusted to suit the application, and all marks are clear and legible.

LEVELER

▲ Now being built by E. W. Bliss Co.'s Rolling Mill Division through a special arrangement with the Voss Engineering Co., of Pittsburgh is a unique type of leveler for flattening sheet, strip and plate steel and nonferrous materials.

The unit produces ideal commercial flatness with the high speed char-

ENTERPRISE
ROLLER CONVEYORS
ARE MODERN INDUSTRY'S
ANSWER TO CONVEYING PROBLEMS

24 IN. "V" ROLL PIPE
CONVEYOR (DRIVEN UNIT)

These rugged individual conveyor units replace many conventional run-out tables and eliminate the need for mitre gearing, long shafting and interconnecting structure. Standard roll designs include V-Rolls, Flat Rolls, Tapered Rolls, Serrated Rolls and Water Cooled Rolls for furnace applications. Various face widths are available. Idler rolls can be furnished for installation between driven units.

For complete detailed information write for Bulletin 501

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THE ENTERPRISE COMPANY
MACHINERY BUILDERS & ENGINEERS
SUBSIDIARY OF WM. K. STAMETS COMPANY · PITTSBURGH
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cut down shutdowns..

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EMBECO
PRE-MIXED
GROUT

Widely used in the iron and steel industry to produce non-shrink grouts for all types of heavy equipment and machinery, including rolling mills, drives, motors, hydraulic presses, planers, shapers, etc.

Many advantages over plain cement-sand grouts—

- *Non-Shrink* with full bedplate contact... maintains alignment.
- *High Compressive and Impact-Resistant Strength*... takes vibration, pounding action.
- *Oil and Water Resistant.*
- *Flowable—Easily Placed* yet does not shrink upon hardening.

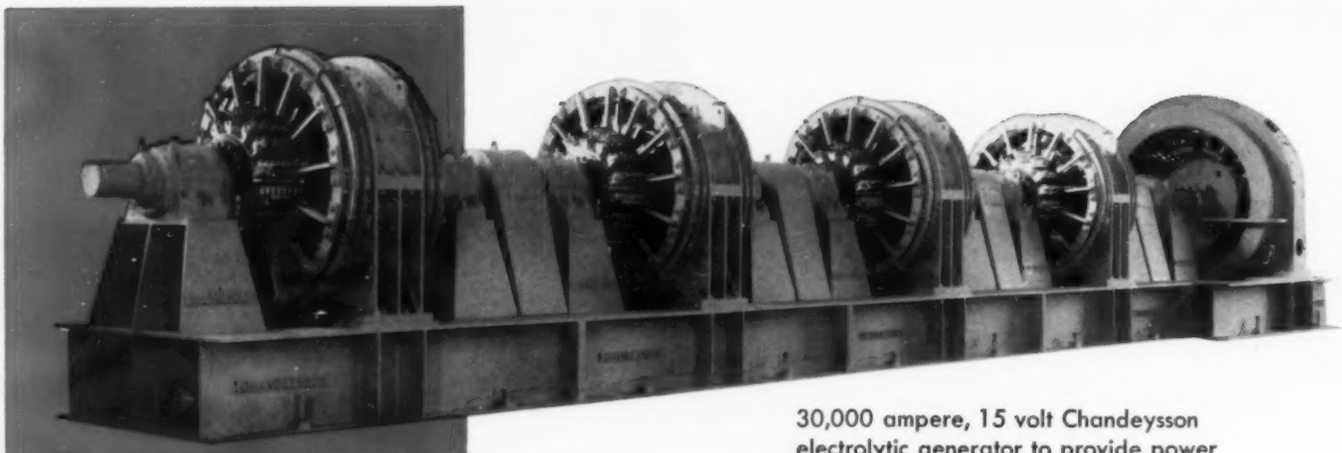
send for booklet

Recommended by leading equipment manufacturers.

EMBECO PRE-MIXED GROUT IS READY TO USE—you add only water. Write for 8 page illustrated booklet.

Creators and Manufacturers of Products to Improve Concrete and Mortar

THE MASTER BUILDERS CO.
CLEVELAND 3, OHIO — Subsidiary of American-Marietta Company — TORONTO 15, ONTARIO



30,000 ampere, 15 volt Chandeysson electrolytic generator to provide power for tin plating at United States Steel's Gary Sheet and Tin Mill.

U S STEEL installs this BIG, NEW Chandeysson ELECTROLYTIC GENERATOR

for a Lifetime of Low-Cost Power Conversion!

How long will this giant motor generator serve dependably, without loss of efficiency? Some Chandeysson units built as long as half a century ago are still in service . . . and this modern Chandeysson is even more efficient and durable than its predecessors.

There's no secret to the amazingly long service life of Chandeysson electrolytic generators. It's simply a combination of the finest, most durable materials; painstaking design for maximum efficiency with a minimum of wear; conservative engineering with ample overload capacity; and craftsmanship by electrolytic generator specialists. To obtain this perfection, all parts of Chandeysson generators except brushes are built in our plant. You can depend on delivery, installation, performance and service.

Whatever your power conversion requirements, you'll save money four ways with a Chandeysson:

1. Use less power
2. Get more out of the power you pay for
3. Be sure of power when you need it most
4. Enjoy lifetime power dividends

FOR FULL INFORMATION mail this coupon . . . or write:

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4076 Bingham Avenue, St. Louis 16, Mo.

CHANDEYSSON ELECTRIC COMPANY
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Company.....

Address.....

City.....Zone.....State.....

acteristics of conventional roller levelers. Although it resembles the latter in several respects, it offers many special refinements.

The machine relies on a set of long, slender, individually-driven work rolls supported by a lattice of short, heavy back-up rollers. These can be precisely adjusted in any direction, either in groups or as a whole. This makes possible accurate control of the deflection produced by the work rolls in the material being flattened with resultant high quality flatness in the finished material.

Bliss will also build the Voss chain roller leveler, another design in favor with sheet metal shops who need commercial standards of flatness.

BILLET TURNER

▲ Designed to aid in meeting the industry's need for faster, more economical conditioning, the hydra-turn bloom and billet turner, developed by Evans Enterprises, makes turning of blooms for inspection or scarfing quick, effortless and safe. Blooms can be lifted into working position and turned so that any desired face is "up" by simple manipulation of a hydraulic control-lever.

Bloom and billet turner is shown in scarfing operation. The turner is completely self-contained with its own hydraulic unit, eliminating the need for bars, hooks or slings.

The operator works on a smooth, uncluttered platform with the work positioned for most efficient use of the torch. Any desired movement of the bloom is accomplished in seconds and no time is lost waiting for the crane or a helper. No bars, hooks or slings which might cause injury to workers are required and hydraulic operation provides smooth operation, always under absolute control of the operator.

The Hydra-Turn is completely self-contained with its own husky, high-efficiency hydraulic unit, powered by a 15 hp motor. It is of all-welded heavy steel plate and structural shape construction, forming a sturdy, rigid unit which can be moved about by fork truck to meet changing working conditions and requirements. It is mounted on heavy, large-area base plates which permit it to be placed and operated on any stable surface without the necessity of providing footers. The power system is completely enclosed to protect it against weather when the unit is used outdoors.

The machine will handle either square sections or rectangular sections where the greater dimension does not exceed the lesser by more

FAST···LEGIBLE BILLET MARKING!

now made possible with the NEW

MODEL 701 PNEUMATIC BILLET MARKER

This new, compact unit stamps ends of billets 4" x 4" or larger with a deep, legible mark as shown above. Unit is mounted on an I-beam track and powered by heavy duty air cylinder. Quick change type holder is kept in stamping position at all times without special guides.

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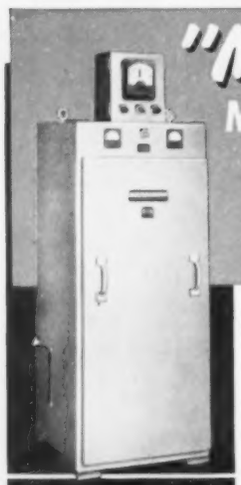

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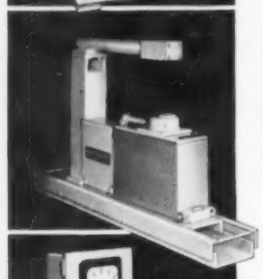
MEASURES THICKNESS ACCURATELY *without TOUCHING the MATERIAL*

Hot or Cold Strip Steel, Brass, Copper, Aluminum . . . Plastics, Foils, Coated Fabrics, Film, Rubber, Etc., Even When Moving At High Speed.



Simple method—the "Measuray" shoots X-Rays through the material—measures its absorption of the rays. Calibrated meter registers plus or minus per cent of deviation from pre-determined standard. Especially useful on hot mills where material can't be checked by contact gages. Also when material can be deformed by contact such as foil.

"Measuray" is accurate to 1% of thickness or less. Quickly pays for itself in reduced scrap.

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Corrugating and Complete Line of Culvert Equipment—Slitting and Coiling Equipment for Ferrous and Non-Ferrous Material in All Capacities—Warehouse and Steel Mill Cut to Length Lines for Shearing and Levelling Sheets from Coils—Shears for Shearing Sheets and Plates Both Underdriven and Overdriven Types in all Capacities up to 1¼" plate.

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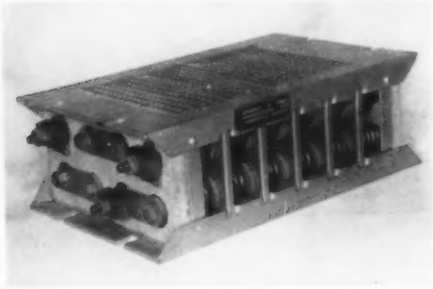
Non-breakable helical coil construction ends burnouts due to warping and buckling of grids.

Sturdy, rugged steel construction eliminates shock and vibration troubles.

Custom designed for your conditions including excessive graphite accumulations.



With a quarter century of resistor engineering, we invite you to take advantage of our experience.

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GUYAN MACHINERY COMPANY

LOGAN, W. VA.

than a few inches, in regular mill lengths. It has a capacity of three 4 in. square or 4 in. longest-side rectangular pieces, two 6 in. to 7½ in. longest-side rectangular pieces or one 8 in. to 12 in. square or longest-side rectangular piece.

REACTORS

▲ Current limiting reactors used to limit short circuit current to safe values and to reduce effect of resulting voltage disturbance are available from Westinghouse Electric Corp.

The reactors are designed for indoor or outdoor service in single or three-phase ratings from 5 to 6000 kva; 300 to 6000 amp; and 1201 to 34,500 volts.

The units will withstand up to 33⅓ times normal full load current for five seconds. The wedge-shaped cleat used in the reactor column has a high dielectric value, and its resiliency to thermal and mechanical shock practically eliminates the aging and maintenance problems. The wedge shape of the cleat assures proper cooling under all conditions by increasing the radiating surface on the inside turns and provides additional mechanical strength by making shorter unsupported spans of cable on the outside turns.

SPEED DRIVE

▲ A wide-range adjustable-speed drive for machine tool feeds has been introduced by Reliance Electric & Engineering Co. The VS-100 Drive affords a speed range of 100:1 with continuous electrical speed adjustment with a high degree of stability over the entire speed range. Capacity of the drive is from ½ to 4 hp. Applications include machines that require continuous speed adjustment up to 100:1 and those which provide even higher speed ranges through the use of simple gear shifts or ratio changes.

The drives are complete "packaged" drives with electronic control panels that are suitable for mounting and integrating with other machine controls. Drive motors are specifically designed for operation from the electronic control units. Reliance Sealpak construction is a feature of the control panels whereby all of the small electronic components are

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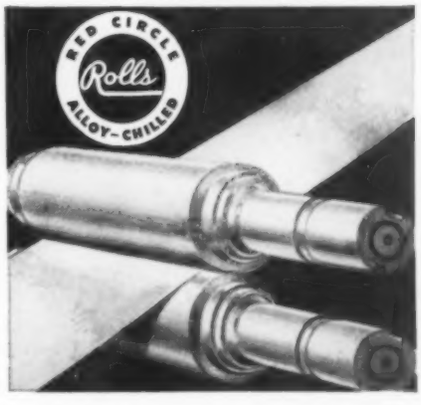

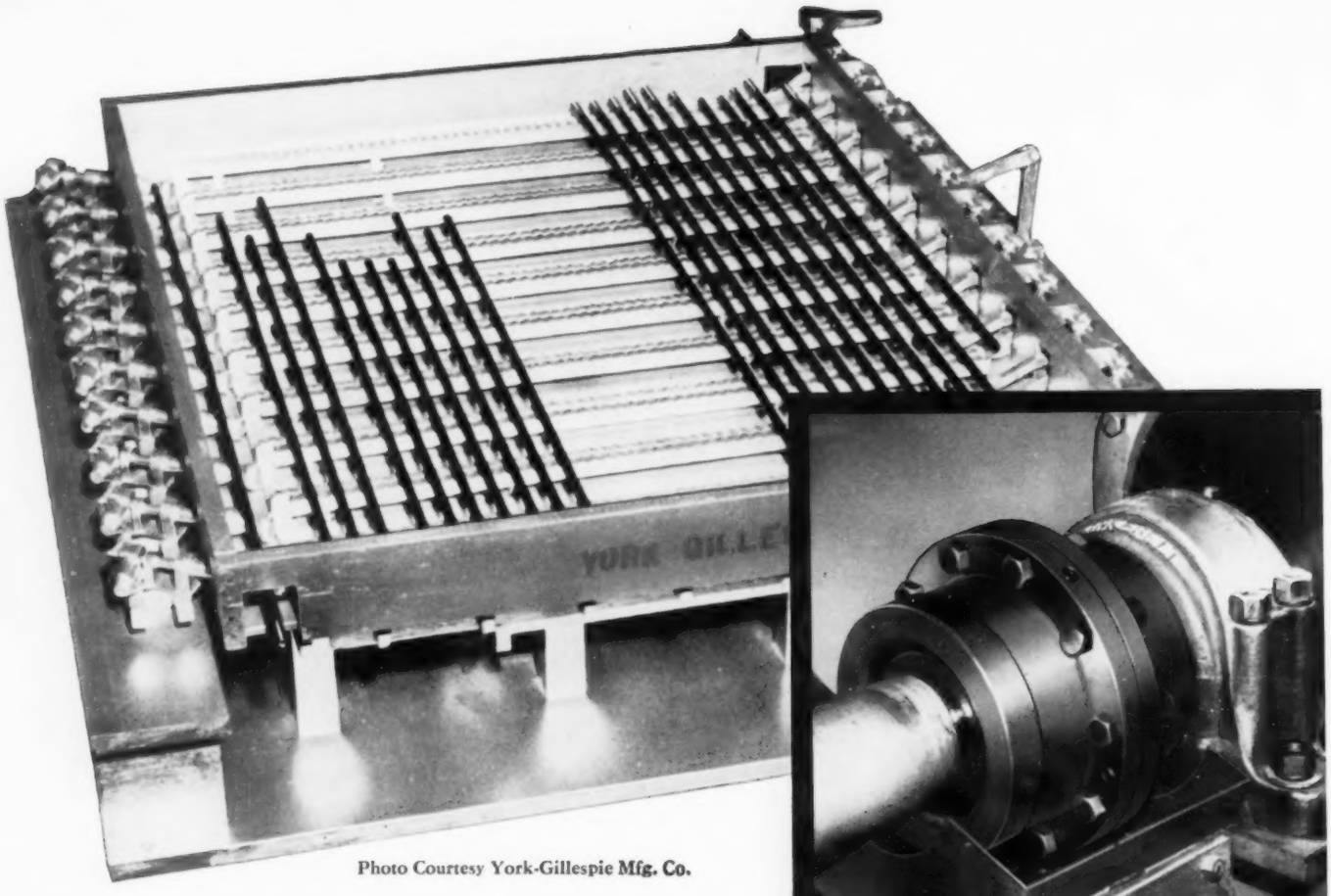

Photo Courtesy York-Gillespie Mfg. Co.

Photo Courtesy Jones & Laughlin Steel Corp.

Fast's Couplings help roll 30 tons of steel per hour through new Jones & Laughlin normalizing and quench tempering furnaces

At the Jones & Laughlin Aliquippa Works, Fast's Couplings are part of a new materials-handling process for transferring tubular steel products through the continuous normalizing and quench tempering furnaces. Pipe tubing is rotated automatically by a series of specially designed racks as it is transferred through the furnace. This design eliminates chill spots and minimizes warpage, insuring uniform heating at capacities up to 60,000 pounds per hour.

Fast's Couplings were used exclusively in this equipment . . . and for good reasons: They are subject to operation at extremely high temperatures that demand Fast's all-steel construction; torque transmission is high (low 3 RPM speed at eccentrics); Fast's Couplings offer mis-alignment protection for long-distance shafting—particularly important because of high temperatures and subsequent shaft growth; and Fast's Couplings are the best "shut down insurance" where continuous, trouble-free operation is essential.

This is another example of how Fast's Couplings fill specialized needs of industry with their famous Fast's construction and performance features. Koppers free engineering can assist you in selecting the right Fast's Coupling for your needs also. Mail the coupon below for a free catalog to: KOPPERS COMPANY, INC., Fast's Coupling Dept., 310 Scott St., Baltimore 3, Maryland.

THE ORIGINAL **FAST'S Couplings**

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Gentlemen: Send me a Fast's Catalog giving detailed descriptions, engineering drawings, capacity tables and photographs.

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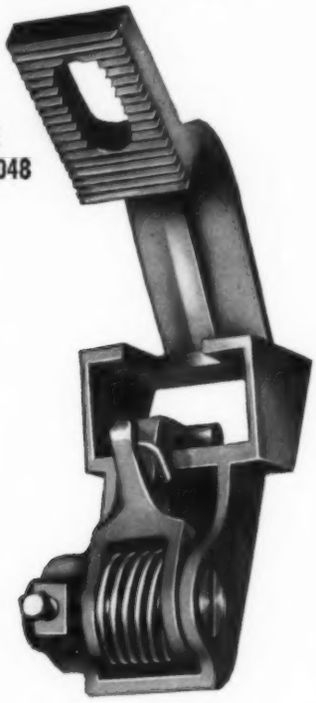

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When your specifications demand BRUSH HOLDERS with high wearing qualities, low maintenance cost — pick from our more than 1,000 types, or have our engineers design your special type.

TYPE PB-3048, industrial, shown is one of many designed and produced for specific applications. . . . The 'something special' in BRUSH HOLDERS is produced by the specialist. Ask FLOWER

WRITE FOR CATALOG 41

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grouped, wired, and sealed in plastic for complete protection from harmful atmospheres, vibration, and shock. Operation of the drive requires standard single-phase power.

For special feed requirements, the drive can be modified to provide extremely close speed regulation by tachometer feedback—addition of an amplifying section, on a "building block" basis, converts the basic panel to a precision regulator.

CHAIN COUPLINGS

▲ Taper-lock chain couplings have recently been added to the Dodge Manufacturing Corp. line of taper-lock sprockets and roller chain.

The new couplings are of a flexible type and permit sufficient relative movement between the hubs to accommodate slight angular and parallel shaft misalignment. The coupling provides a strong and positive, yet compact, direct coupling of the shafts.

Among the features of the new couplings are taper-lock bushings. These bushings are available immediately from distributors' stocks in the desired sizes—no reboring is required. They make easy installation upon full size or normally undersized shafts, yet give the equivalent of a shrunk-on fit.

The chain is a double-width, standard precision chain conforming to American Standard Association specifications. The additional bearing area permits higher hp ratings and longer wear life. Quick disconnecting of the shafts is possible by removing the one coupling pin and unwrapping the chain from the hubs.

Sprocket teeth are accurately cut and hardened. Two more teeth are furnished in each flange than are found in the ordinary coupling. This additionally contributes to long life and power-transmitting capacity. Clearance between the teeth and the chain side plates permits freedom of movement.

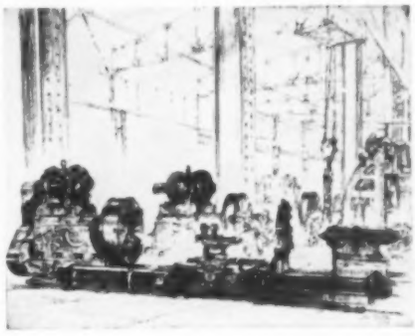
RECEIVERS

▲ Announced by the Bristol Co. are miniaturized Metameter Telemeter receivers, which can be used in graphic panel arrangement. These receivers are available either as indicators or strip-chart recorders, and

(*Please turn to page 218*)

Don't junk your old lathe just because it has begun to chatter and shake.

Now is the time to have your outdated machine tools returned to their original performance levels through Simmons Engineered Rebuilding—at half the cost of new equipment.



Engineered Rebuilding by Simmons *unconditionally guarantees* that your machine tools will equal or exceed manufacturers' original specifications.

And, through modernization, Simmons is adapting old machines to high-speed, high-precision production that was unheard of when the tools were new.

Today: look into the important economies in production, maintenance, and liberal tax allowances available when you turn the old machines in your plant into precision equipment for today's production!

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Simmons Machine Tool Corp.

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Unconditional guarantee... our standard since 1910

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ASKANIA OPEN HEARTH CONTROLS

In the new open hearth shop at Inland Steel Company's Indiana Harbor works, this panel houses one of four complete Askania control systems.

No control replaces the skill and judgment of an experienced open hearth operator. But an Askania installation adds to his skill by putting accurate and dependable control at the tips of his fingers. It is truly the first helper's first helper.

This is modern open hearth control—completely automatic but flexible. In the hands of your operators, it is a tool that helps them make more steel and better steel for less money. Furnace pressure is controlled to a hairsbreadth. Air flow and fuel flow are precisely proportioned to each other. Flow of atomizing steam to the burners is closely regulated to the operator's setting. Automatic reversal cuts fuel-off time to a few seconds, uses checker heat most effectively. A complete record of all that happens lets the operator duplicate his results in heat after heat.

Steel men rely on Askania Controls—common-sense controls that make their job easier and the results better. Askania equipment is simple and sturdy—designed and built to do the hardest jobs for the longest time.

Write for Bulletin 115, Askania Open Hearth Furnace Control.

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COMPLETE OIL SEAL REFERENCE MANUAL

Here, in one handy book, is everything you need to know about America's leading oil seals. In 28 pages, fully illustrated, J-M tells you how you can improve performance and cut costs with more effective sealing, longer lasting Clipper Seals.

There are detailed descriptions of all the latest standard seal designs including the new LPD and RPD . . . as well as those for special applications. Uses in petroleum, automotive, mining, earth-moving, aviation, iron and steel, machine tool and process industries are covered thoroughly.

Documented case histories tell how leading manufacturers have profited from the superior performance of Clipper Seals. Full use is made of every type of illustration for complete descriptions of important applications. Close-up photographs show how to install split Clipper Seals in limited space.

Learn how Clipper Seals' many advantages can cut costs for you . . . by simplifying design problems, speeding assembly and providing improved lubricant retention and dirt exclusion under all conditions. Write for free brochure PK-71A to Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ont.

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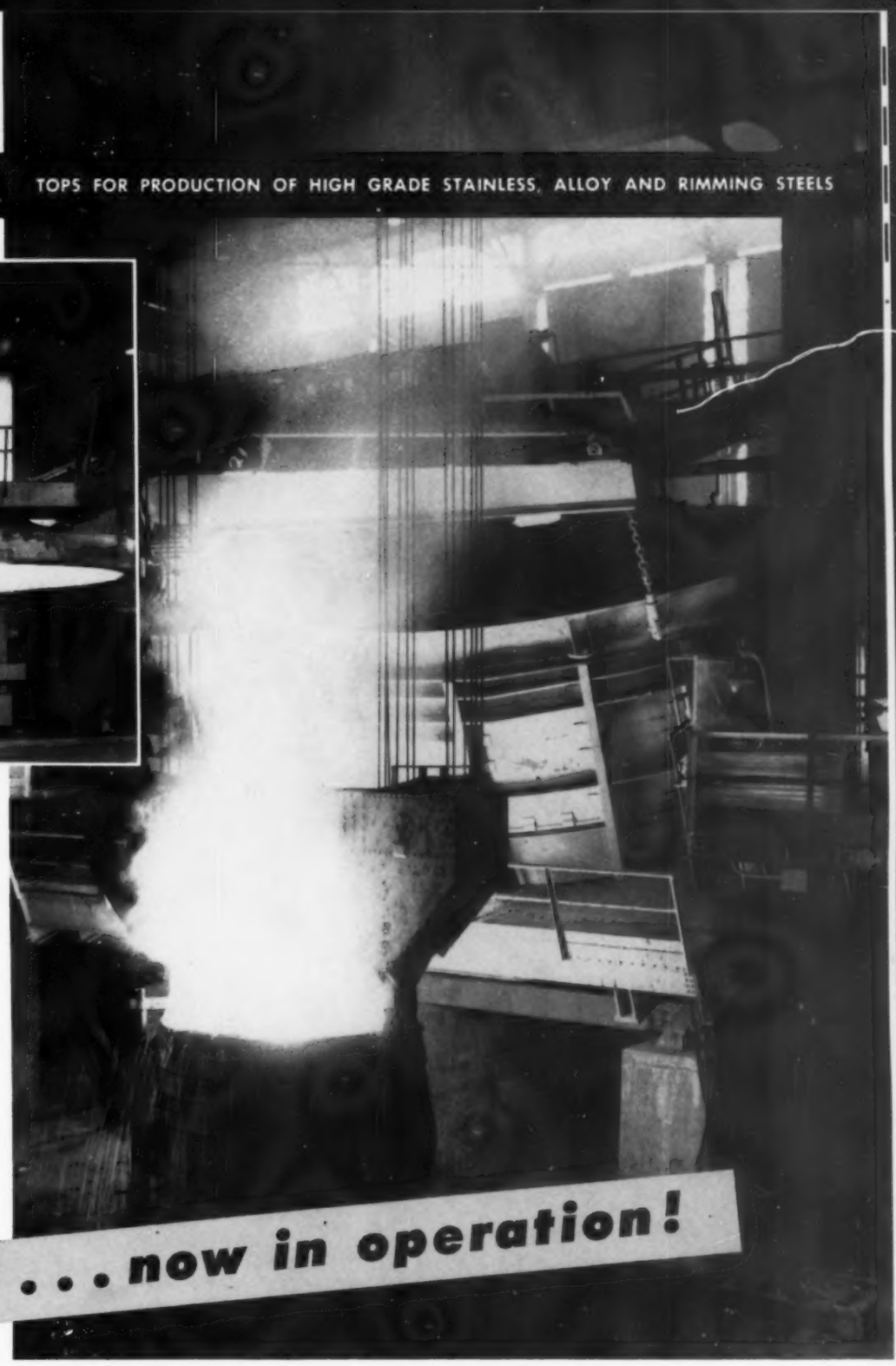

World's Largest Electric Furnaces

. . . now in operation!

INSTALLED in the ultra-modern mill of McLouth Steel Corporation, in Detroit, these giant *200-Ton* Heroults are the largest electric melting furnaces ever built. With an inside shell diameter of 24'6", they have a rated charge capacity of 400,000 pounds, and each is designed for efficient operation on 25,000 to 33,000 KVA transformer capacity. Featuring a swing-type roof, these furnaces are equipped with the finest, most up-to-date mechanism and electrical controls available.

McLouth's adoption of electric furnaces of this size sets a precedent. It is a "first" which should conclusively prove that, in addition to closer control, higher uniformity, better performance, and greater safety, large capacity Heroult Electric Furnaces are an economically sound investment—even for high tonnage steel-making.

We welcome an opportunity to help you select and install the furnace best suited to your particular requirements.

ASK FOR NEW CATALOGUE. *Contains latest information on modern electric furnaces—types, sizes, capacities, rating, etc. Write Pittsburgh Office for free copy.*

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He's alive and you helped

People still die from tuberculosis—this year one American every twenty-seven minutes!

Yet the money which you give for Christmas Seals has helped to save thousands of lives.

Christmas Seals fight tuberculosis year-round—through education, case finding, patient rehabilitation, and basic research on TB control, treatment, and possible prevention.

Make Christmas Seals a part of *your* holiday giving. From now to Christmas send no card, letter, or package without the Seals that save lives. And send in your contribution today.

Buy and use Christmas Seals

Because of the importance of the above message, this space has been contributed by

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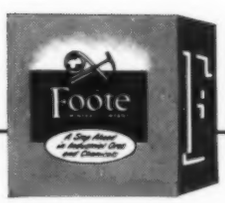
In a matter of seconds, this small packet of Foote Rimex will intensify the rimming action in each ingot of molten rim steel. Result—ingots with a thick skin of high-quality steel relatively free of blowholes. Ingot growth is minimized . . . higher quality is assured without obnoxious, toxic fumes. No wonder Rimex is widely used for producing rim steels that meet rigid quality requirements for modern deep drawing operations.

Rimex is one of the specialized additives developed by Foote to meet the needs of the steel industry. Whether you need a new type of steel additive or are interested in the standard additives, it will pay you to contact Foote.

Foote metallurgical engineers stand ready to serve your steel additive needs. A letter will place their experience at your command.



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DIVIDENDS... in human lives

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If you can answer "yes" to most of them, you—and your company—are doing a needed job for the National Blood Program.

- ○ HAVE YOU GIVEN YOUR EMPLOYEES TIME OFF TO MAKE BLOOD DONATIONS?
- ○ HAS YOUR COMPANY GIVEN ANY RECOGNITION TO DONORS?
- ○ DO YOU HAVE A BLOOD DONOR HONOR ROLL IN YOUR COMPANY?
- ○ HAVE YOU ARRANGED TO HAVE A BLOOD-MOBILE MAKE REGULAR VISITS?
- ○ HAS YOUR MANAGEMENT ENDORSED THE LOCAL BLOOD DONOR PROGRAM?
- ○ HAVE YOU INFORMED EMPLOYEES OF YOUR COMPANY'S PLAN OF CO-OPERATION?
- ○ WAS THIS INFORMATION GIVEN THROUGH PLAN BULLETIN OR HOUSE MAGAZINE?
- ○ HAVE YOU CONDUCTED A DONOR PLEDGE CAMPAIGN IN YOUR COMPANY?
- ○ HAVE YOU SET UP A LIST OF VOLUNTEERS SO THAT EFFICIENT PLANS CAN BE MADE FOR SCHEDULING DONORS?

Remember, as long as a **single** pint of blood may mean the difference between life and death for **any** American . . . the need for blood is **urgent!**

NATIONAL BLOOD PROGRAM

America's blood bank needs **more** blood, **now**. Be a regular depositor and know that your dividend is saving a life of some American—somewhere.

It may be a soldier shot down in battle, suffering from **shock**. Or someone here at home, sick and in dire need of new blood to restore life. A mother in childbirth, or a child in an accident.

America must give. America is **you**. Won't you call your Red Cross, Armed Forces or Community Blood Donor Center right now, for an appointment?

GIVE BLOOD

...give it again and again

This C-51 deseaming blowpipe opens transverse plate welds in steel barge bottoms 7 times faster than the previously used process.

Barges get new lease on life...

FOR 70% LESS COST

Deseaming blowpipes have cut the time required to remove these steel barge bottoms from 4 days per barge, to only 1½—and cut costs $500 per barge. . . .

In this operation, the barges were rolled over in the water. Bottom plates were deseamed and removed, and then new plates UNIONMELT welded in position. Before removing the old plates, it was necessary to "open" seam welds, plug welds, and rivets. The deseaming blowpipes did this work with maximum speed and economy—and with minimum nicking into the support members beneath the plates.

Deseaming blowpipes operate with a low-velocity oxygen stream, and make a wide pass in metal at high speeds. The depth of penetration is controlled by regulating oxygen pressure. Lightweight, easy to handle deseaming blowpipes are speeding production and repair operations throughout industry.

For more information on this or any other of LINDE's modern, money saving processes, call your local LINDE representative. Start saving now, call him today.

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instant heat where

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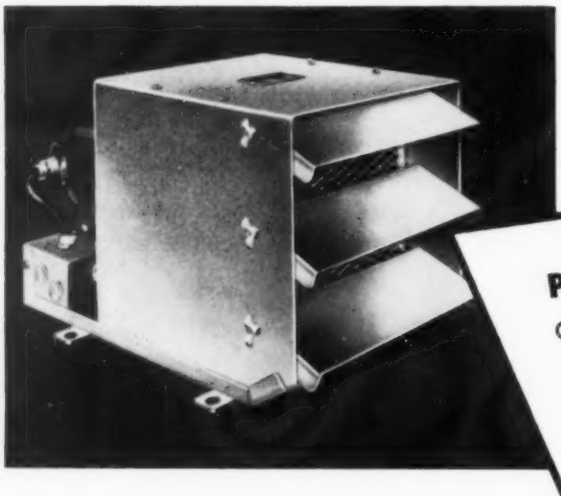

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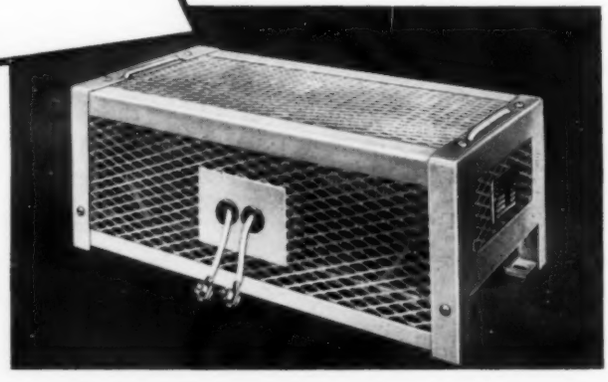

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EQUIPMENT NEWS

(*Continued from page 207*)

occupy a panel space only five in. square.

The indicators and recorders can be used to receive telemetered signals of any of the unusual variables, such as pressure, flow, temperature, differential pressure, and such electrical measurements as voltage, current, and power. They are identical in appearance to the standard Bristol Metagraphic pneumatic transmission instruments for short distance transmission of measurements, and thus provide for uniform appearance in a graphic panel presentation, as well as in conventional instrument panel arrangements.

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▲ A special new dust control unit has been developed that removes microscopic solids, fumes and odors from exhaust gases. It can be used anywhere impurities are encountered of extremely low and even submicron size particles.

Efficiency up to 99 per cent has been obtained in test situations with dust loadings at five grains per cubic feet and 70 per cent of the material below five-micron particle size.

The unit, known as the Type A Hydro Precipitator Scrubber, is a development of the Johnson-March Corp. It collects dust by hydro-compressing exhaust gases through a system of multiple tubes into a water chamber. This produces a highly efficient scrubbing action. The violent water agitation set up causes secondary pressure turbulance and additional scrubbing action in the tube chamber.

Book Reviews . . .

"Handbook of Engineering Materials," by Douglas F. Miner and John B. Seastone has just been published by John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. This handy reference book contains 1,362 pp., 5½ x 8¼, is cloth bound and sells for $17.50 per copy. The book consists of four sections on the following topics: general information on materials, metals, non-metals and construction materials. In a consistent and usable style, it covers not only the commonplace materials of metallurgy but also new developments in other fields that have significance to the engineer. More than a thousand tables cover basic aspects of engineering materials, thus keeping descriptive text to a minimum. The book serves as an authoritative guide to aid the engineer in selecting materials for given functions, with emphasis on the principal factors considered in such a selection—properties, adaptability to fabricating methods, availability and cost.

But why MEN over 45?

Our doctors still don't know *why*, but if you are a man over 45 you are six times as likely to develop lung cancer as a man of your age twenty years ago. They *do* know, however, that their chances of saving your life could be about *ten times* greater if they could only detect cancer long before you yourself notice any symptom. (Only 1 in every 20 lung cancers is being cured today, largely because most cases progress too far before detected.)

That's why we urge that you make a habit of having your chest X-rayed every six months, no matter how well you may *feel*. The alarming increase of lung cancer in men over 45 more than justifies such precautions. Far too many men die *needlessly!*

Our new film "The Warning Shadow" will tell you what every man should know about lung cancer. To find where and when you can see this film, and to get life-saving facts about other forms of cancer, phone the American Cancer Society office nearest you or simply write to "Cancer"—in care of your local Post Office.

American Cancer Society

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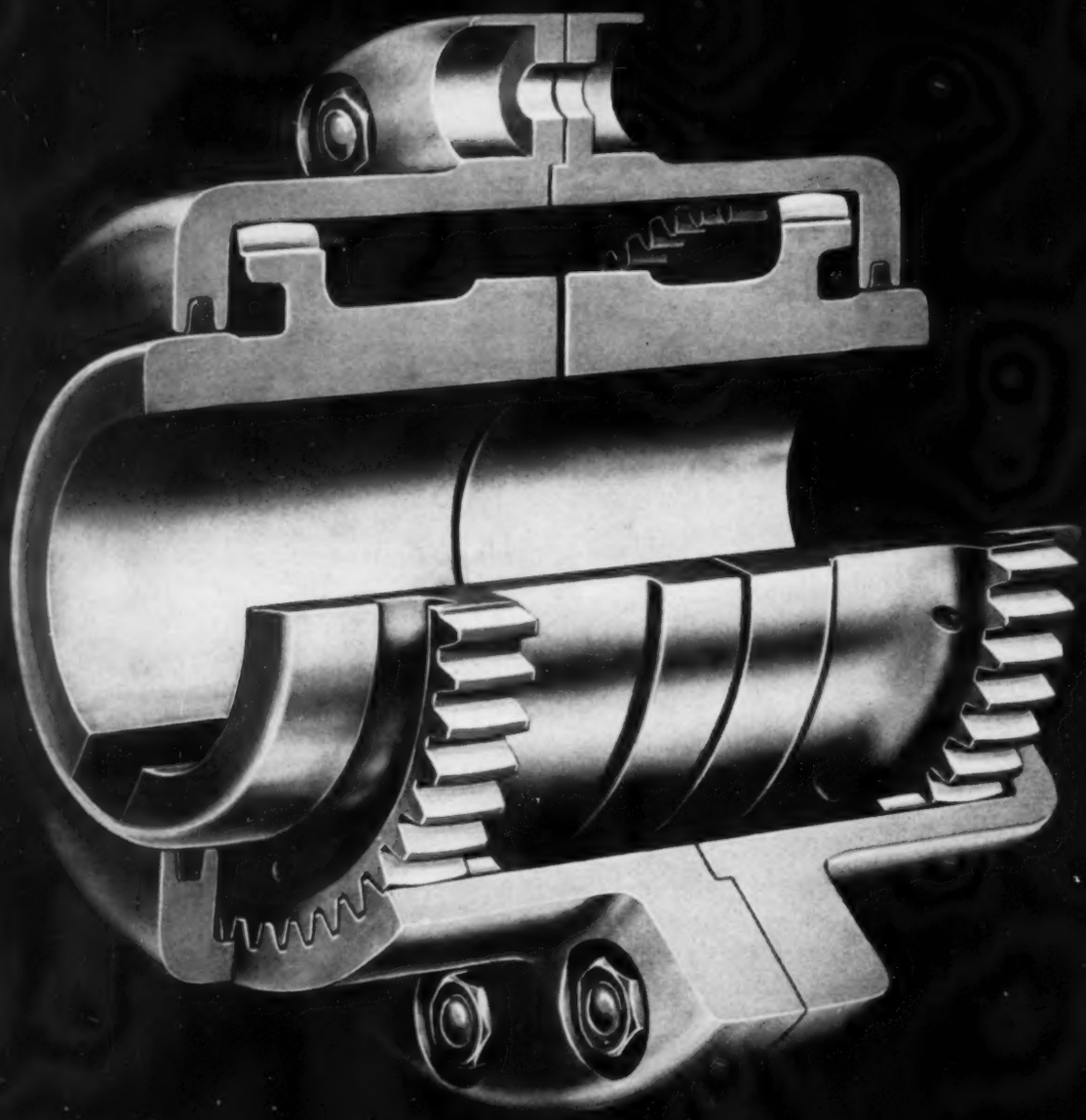
POOLE



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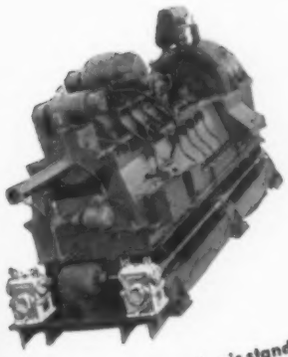

Cleveland worm gearing is standard on these fully-automatic machines which thread oil field pipe to rigid A.P.I. specifications, ranging from 1¼" to 13⅜" O.D. In addition to worm gearing inside the machine, note two Cleveland Worm Gear Speed Reducers in foreground.

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Speed Reducers

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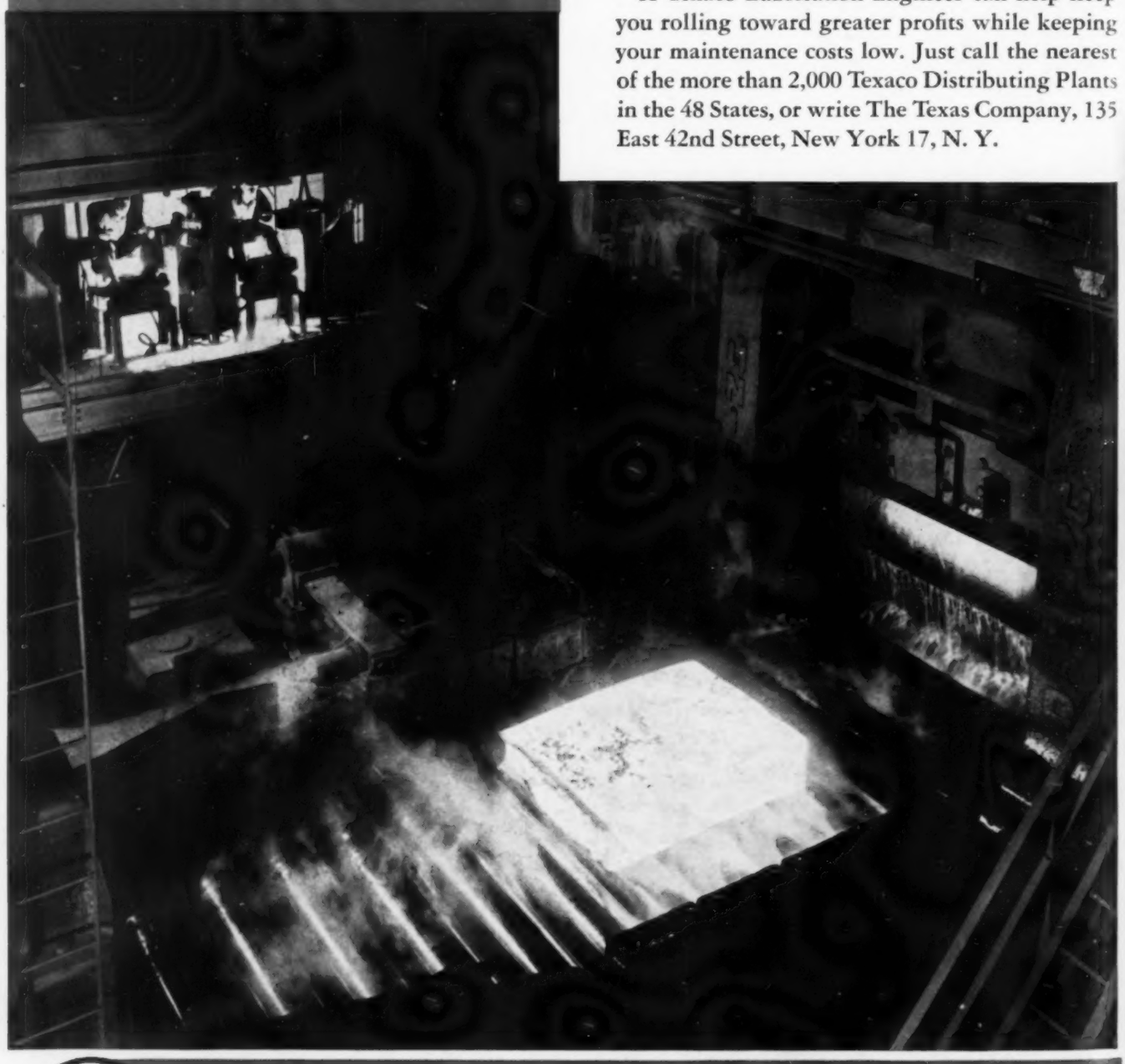

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